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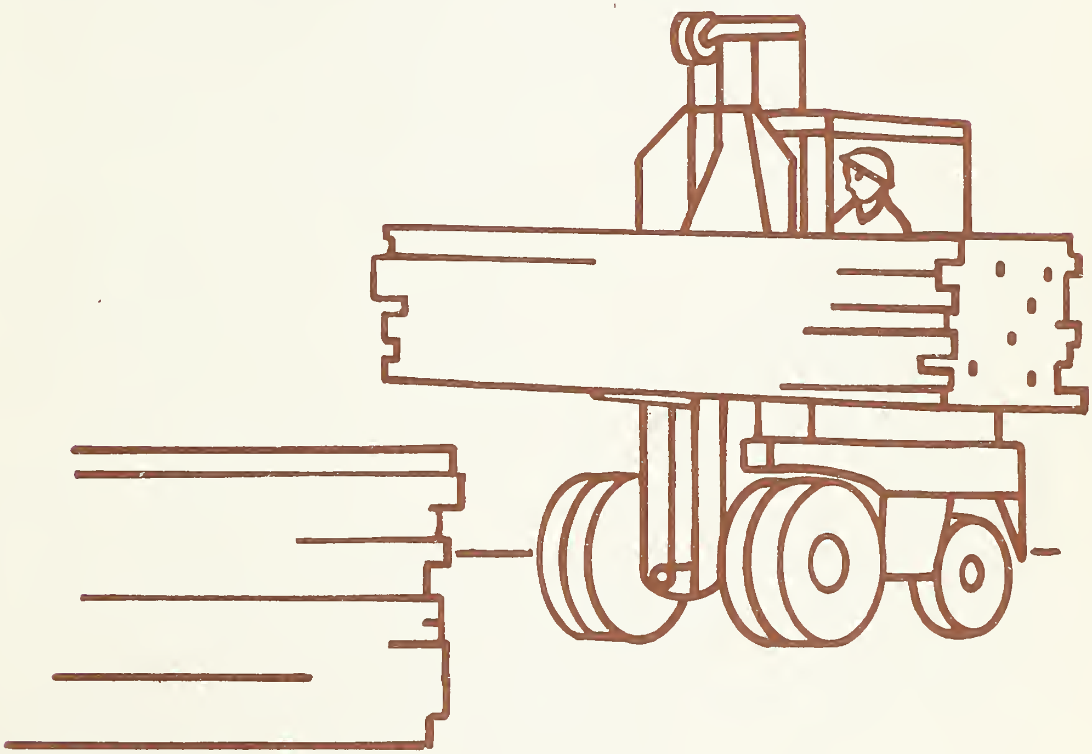
TIMBER DEVELOPMENT OPPORTUNITIES IN THE REPUBLIC OF VIETNAM



International Development Center • Economic Research Service
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and the Vietnam Ministry of Agriculture and Land Development

ABSTRACT

The forest land of South Vietnam has suffered from centuries of neglect and abuse. While this still continues, a substantial area of commercial-size timber remains, mostly hardwoods. If this timber is carefully managed and supplemented by extensive regeneration of deforested land, timber products can make a major contribution to Vietnam's economy. To accomplish this will require large, intensive, and consistent forestry and timber development efforts.

Keywords: Vietnam, Southeast Asia, timber, resource development, forestry, policy, industrial development, developing countries, exports.

Note: All values in this report are expressed in U.S. dollars.

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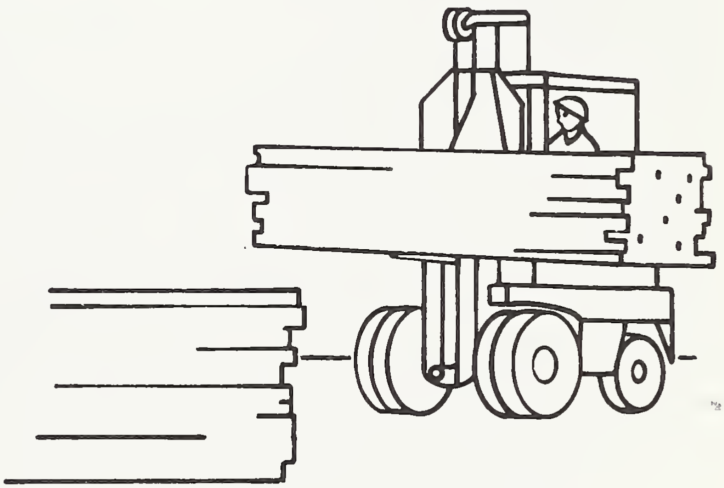

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PREFACE

This is the second of two reports dealing with the timber industry opportunities in South Vietnam. The first, Export Opportunities for Vietnam Timber Products In Japan, Korea, Taiwan and Singapore (FDD Field Report 42, February 1974), discusses the timber market outlook in the Far East. The following discussion examines the timber resource situation in South Vietnam, development opportunities, problems involved, and policies and programs required to take full advantage of the timber industry potential.

These studies, along with similar studies of fisheries and agriculture, are being conducted by the Economic Research Service of the U.S. Department of Agriculture (USDA) for the Vietnam Mission of the U.S. Agency for International Development (USAID), which is financing the projects. The primary purpose of the studies is to explore export opportunities available to Vietnam; however, attention has also been paid to broader development opportunities and problems. These analyses have been under the supervision and leadership of USDA/USAID advisor Shelby A. Robert.

Information and counsel have been received from many sources. We are particularly grateful to the assistance given by Shelby A. Robert as well as that received from six foresters from the U.S. Forest Service stationed in South Vietnam: Jack B. Shumate, Walter Pierce, Carl W. Swanson, John H. Murray, Jr., Mervin E. Stevens, Stuart H. Slayton, and Roy C. Gandy.

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SUMMARY

Forest land is the most extensive of the Republic of Vietnam's land resources. Between 13 and 14 million hectares of the total land area of 17 million hectares can be classified as forest in that it bears or once bore trees and has not been converted to permanent cultivation or settlement. Allowing for the expanded needs of agriculture and other land uses, it seems likely that at least 9 million hectares in South Vietnam will, in the long run, be best suited for timber growing.

In a productivity sense, the forest is presently a diminishing and deteriorating resource. Centuries of shifting agriculture, fires, destructive cutting, and, in recent decades, warfare have taken a heavy toll of timber and timber growth. Millions of hectares that once bore mature stands of merchantable and potentially merchantable timber now are covered with scrub vegetation.

There still remains in the hinterlands, however, a sizable area of productive forest--apparently totaling about 6.4 million hectares. This forest can contribute substantially to the development of South Vietnam if it is properly used and managed. If, in addition, the timber productivity of the rest of the land best suited for timber growing is restored, the total contribution of the forest can be remarkably high. The annual output of timber products in South Vietnam is presently worth about $100 million. It could be raised to $1 billion or more by the end of the century. For a country trying to develop an economic foothold, this is a very important opportunity.

At this stage, however, a $1 billion output of forest products has to be regarded as but a theoretical possibility because of the almost total lack of forestry and the limited constructive industrial development up until now.

In pondering the decision as to what priority should be given to forestry and timber industry development on a national scale, several realities are of exceptional importance. The population of South Vietnam is likely to double the present 20 million people by the end of the present century, creating a great additional burden on economic development. Barring the discovery of great new mineral wealth, the forest land is the principal nonagricultural resource upon which economic growth can be based. Because the forest land is widely dispersed, it offers a unique opportunity to strengthen South Vietnam's rural economy and attract more people away from the cities to the country where the quality of life can be greater and energy requirements less.

Although the forestry potential is excitingly large, there is a question as to how much of that opportunity can be captured under the circumstances surrounding South Vietnam today. It requires establishing a control over the forest (nonexistent at present) and the institution

of highly disciplined timber management. It requires forebearance in the use of the existing sawtimber to spread it over the next several decades, along with a large tree planting program to more quickly harness the enormous production potential of the forest. Timber industry expansion must be carefully designed if it is to do the most good.

What it boils down to is that, although South Vietnam can make some big economic gains by developing the forest resource, the task will not be easy. An aggressive, continuing, and consistent public effort will be required. Six issues should have top priority at this time:

1. An official policy decision is needed soon, specifying the reliance that will be put on timber development in South Vietnam's effort to gain economic muscle. Without such a goal it will be impossible to have a consistent and efficient program of development.

2. Land-use commitments must be made soon to minimize misuse, destruction, and wasted effort. Land classification based on soil and hydrologic characteristics, community needs, and other factors is necessary to definitely establish which areas are to be used for timber growing and which for other purposes.

3. The most capable brains available should be assigned the task of outlining a long-range strategy, in all of its ramifications, for protecting and managing the forest and guiding industrial development. The quality of such blueprints for future action will be a crucial factor in the success of any national effort.

4. The governmental structure for forestry and timber industry development should be overhauled to handle greatly increased responsibilities. South Vietnam is presently unprepared to handle a large forestry and timber development program. Steps should be taken to develop a dynamic organization with adequate authority, to increase the number of trained professionals, and to upgrade technical knowledge through expanded research.

5. Effort to attract and coordinate assistance from international agencies and developed countries should be increased. South Vietnam needs all of the help it can get, but the growing world demand for timber should provide some leverage for getting forestry assistance and for drawing upon some of the developed countries for technical aid and advice.

6. A crash effort should be made to restock lands deforested by centuries of neglect and abuse and decades

of war. Continued fighting prevents moving ahead immediately with forestry development in much of South Vietnam. However, there are several million hectares of deforested land that are militarily "secure." These lands should be planted at the rate of 150,000 hectares or so annually until productivity is restored on most of the area. Such a massive program would have the immediate advantage of providing very much needed employment.

INTRODUCTION

The Republic of Vietnam (South Vietnam) has a land area of 17.2 million hectares, about 3 million currently cultivated. A smaller area is occupied by cities, towns, settlements, and roads, and the rest is timber, grass, brush, and swamp.

An estimated 6.4 million hectares have sufficient trees on them to be considered forested today. However, a much greater area was originally timbered, and timber growing is undoubtedly the best use for more than 6.4 million hectares. There are probably 13 million hectares of "forest land" in South Vietnam. This includes low-lying lands that once grew mangrove but now are covered with reeds, nipa palm, grass, and other vegetation. It also includes areas deforested over the years by the Montagnards and others as they have cleared temporary farm plots, areas on which bamboo has taken over, as well as other areas which today have few trees because of fires and other factors.

Most of the arable portion of the 13 million hectares of forest land will sooner or later be required for permanent cultivation to feed South Vietnam's rapidly expanding population. It has been estimated that the total potentially arable area in South Vietnam is 6 million hectares, or about twice the present cultivated area. 1/ An estimated 4.3 million hectares will be required for farm crops in 1981. 2/ Even if all of the 6 million hectares of potentially arable land is put to that use, however, and another couple of million hectares are devoted to living areas, roads, industrial sites, and other purposes, there will still remain at least 9 million hectares primarily valuable for tree growth.

A very important question today is how much the forest land--both the part with trees and the part without trees--could contribute to the economic well-being of South Vietnam in the future. How much income and how much satisfaction of material needs might this area provide in addition to its environmental role? A second question is, how can the desired production level be achieved?

This report provides broad answers to both questions. After 25 years of war and insurgency, there is little reliable forestry information. Consequently, any answers at this stage will only be general, at best. Until the foresters can get back into the timber to measure it and to determine what is taking place, no one can be specific and precise regarding opportunities, problems, and actions desirable. Nevertheless, it is important, even in the absence of

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1/ Thai Cong Tung. Agriculture Development Planning and Zoning in South Vietnam, Agricultural Research Institute, Ministry of Land Reform, Agriculture, Fishery and Animal Husbandry Development, Saigon. 1972.

2/ Information from Richard Foote, USAID, Saigon, Vietnam.

Figure 1. The centuries-old practice of burning off mountain sides to create clearings that can be farmed for 2 or 3 years has taken a heavy toll of timber. In countless instances thousands of dollars worth of trees have been burned to grow farm crops worth a few hundred dollars.

specific knowledge, to determine what role the forest land might play in the future of the Republic of Vietnam. That, in essence, is the purpose of the following discussion.

BACKGROUND

As in most tropical countries, the forest history of Vietnam has been one of continuing decline. Attrition has accelerated in recent decades. Shifting agriculture has been part of the scene since early days. For centuries, the mountain people have cut and burned small clearings in the forest, farmed these plots for several years, then moved on to new areas, returning several decades later to farm again after fertility had been naturally restored to some degree.

Some of the shifting agriculture areas have reverted to timber, but many have been taken over by brush and other nontimber species. In the long run, a more serious consequence undoubtedly is soil erosion and loss of fertility. Soil damage has been extensive, but no one can say how much the productivity of the forest land may have been reduced (Figure 1).

In 1953, there were 105 power-driven sawmills in South Vietnam and 100 hand-operated, whipsaw operations. The number has fluctuated since then, but, by 1973, the whipsaws were almost all gone and there were somewhat more than 500 sawmill companies with twice that many headrigs; there were also two plywood plants, a particle-board plant, and four small paper mills, two of which produce some of their own pulp from pine logs and rice straw. With some exceptions, the timber industry can be described as disorganized, inefficient, wasteful, and really not suited in its present form for the kind of modern production we are considering in this report.

Some of the problems arise from the smallness of the individual plants, but they go beyond that. In the case of the saw-mills, poor techniques and inadequate plant maintenance have, in many instances, resulted in inferior lumber. Modernization is needed to improve both quality of product and utilization of timber. This will involve improving equipment and practices of existing plants and the establishment of many new plants. In up-dating industries, the following characteristics must be sought:

--Steady operation for production rather than for custom orders.
--Uniformly good products in contrast, for example, with wavy lumber resulting from improperly maintained saws and tracks.
--Use of most of the species in the forest as they occur.
--A high rate of recovery; i.e., maximum product output per unit of log.

In 1948, the timber cut for lumber, plywood, and other nonfuel uses was reported at 125,000 cubic meters, climbing to 275,000 in 1953. In 1973, the timber cut was 746,000 cubic meters. Unfortunately, there has always been a large unreported timber cut, and there is no agreement as to its extent. The official figure of fuelwood cut (109,000 cubic meters in 1970 and 79,000 in 1973) likewise is extremely low. Total annual cut of timber for all purposes today is probably between 1 million and 1-1/2 million cubic meters.

Considering what the forest could do, an annual drain of even 1-1/2 million cubic meters is certainly not excessive. However, concentration of cutting in certain parts of the forest; overcutting of the preferred species; wood waste by loggers who have left potentially usable logs behind; the almost complete absence of timber management practice; constant hacking away at the reproduction by fuel-wood cutters; destruction by military action; failure to control fires;

Figure 2. Fuelwood shortages have forced the cutting of brush and small trees. The completeness of the utilization has stripped many areas of the trees needed to provide growing stock for sawtimber.

and a general disregard for the forest, as such, have resulted in a steady and apparently accelerating decline of timber resources.

This is hardly a new discovery. Pierre Gouron wrote in 1945: "Most of the forests have been exploited by man, who has extracted the most precious varieties from them, or else they have been ravaged by ray (shifting agriculture)."3/ He appears to have somewhat overstated the extent of the damage, but his description of the problem was certainly accurate.

Wherever there have been people in South Vietnam, cutting of wood for direct fuel use or for making charcoal has always been an

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3/ Pierre Gouron. Translation of L'Utilization du Sol en Indochine Francaise. Publication 14. Centre de Etudes de Politique Estrangere, Univ. of Bordeaux, Paris.

essential activity. Around larger communities, the continual search for wood has virtually depleted all of the burnable material. Scarcity has reached the point where women and children spend countless hours collecting twigs and leaves to burn. In widening circles around these communities, the forest land has been robbed of the young trees required for future production of sawtimber. Along the coast, in some cases, trees planted to stabilize sand dunes have been cut for fuelwood (Figure 2).

Damage by uncontrolled timber and fuelwood cutting, fire, and shifting agriculture has been further aggravated by military action. Flamm and Cravens estimated that, by June 1970, 1.6 million hectares of forest had been destroyed or damaged by bombs, shell fire, defoliation, and other war activities. 4/ Just how much timber was lost and how great the harm done to the growth capability of the land, while obviously large, is still a guess. Continued fighting has made a systematic appraisal impossible. 5/

Military shrapnel is imbedded in many trees, constituting a hazard to saws and veneer knives. However, the damage is far less severe than sometimes believed--probably about one-half of 1 percent loss in usable wood. Modern metal detecting equipment can readily deal with the problem.

The French sought to bring system and control to forest management in Vietnam when they established more than 2-1/2 million hectares of forest reservations, dating back at least to the 1920's. The idea was to supervise cutting and bring the forest under management. They also began research into the silviculture of Vietnamese forests and inaugurated a tree planting program in 1930.

The gains made by the French have in large part been lost in the chaos since they left. Reserved forests are reserved in name only. Their boundaries have no meaning. Some of the forests have been completely liquidated; others seriously depleted. These are consequences of lack of control. Most of the forest in South Vietnam is publicly owned and under the direct supervision of the Directorate of Waters and Forest. Yet, this agency has been virtually powerless to control and manage the forests.

As noted earlier, despite the drubbing it has taken, South Vietnam still has about 6.4 million hectares of forest land presently bearing timber.

4/ Barry R. Flamm and Jay H. Cravens. "Effects of War Damage on the Forest Resources of South Vietnam," Journal of Forestry. Nov. 1971. See also Arthur H. Westing."Forestry and the War in South Vietnam," Journal of Forestry. Nov. 1971.

5/"Part A-Summary and Conclusions," The Effects of Herbicides in South Vietnam. National Academy of Sciences, Washington, D.C. 1974.

Timber type	Million hectares
Good to excellent hardwood stands	3.0
Poor to fair hardwood stands	2.8
Pine stands	.2
Mangrove	.4
	6.4

This area is believed to contain about 420 million cubic meters of timber in trees 10 centimeters in diameter and larger. Much of this wood is too small to be utilized for nonfuelwood purposes. The volume in merchantable trees 50 centimeters in diameter and larger is believed to be about 150 million cubic meters on the total forested area.

FUTURE TIMBER NEEDS

Before considering the timber supply situation there are two questions to be answered. First, how great will the domestic demand for timber products become? Second, what will the opportunity be for marketing timber products in excess of Vietnam's own needs?

DOMESTIC DEMAND

Once South Vietnam returns to a more orderly existence, the domestic need for timber products will far surpass previous levels. Post-war construction should account for part of the rise in demand, but a more fundamental factor is the expected rapid increase in population between now and the end of the century and the back-breaking load this will put on the natural resources as well as on Vietnam's institutions. The present energy shortage is a sharp reminder that South Vietnam is not abundantly endowed with resources, a situation that places added burden on the resources it does have.

In 1960, South Vietnam had 14.1 million people. By 1973, the influx of refugees and a high birth rate had raised population to 19.9 million. In these 13 years, despite war casualties, there was a 41 percent population increase (about 2.7 percent annually). The Directorate General of Planning has projected a 3 percent annual increase through 1975.6/ Recently started efforts to secure family planning may eventually slow the rate of increase. If it is reduced to 2-1/2 percent annually between 1980 and 1990 and stabilizes at that rate, there will be 41 million people in South Vietnam by the year 2000 (Figure 3). With a 2 percent growth rate after 1980, there still would be 36 million people by the end of the century. These larger numbers of people are obviously going to create great strain on the country's resources.

6/ Four-Year National Economic Development Plan, 1972-1975. Government of the Republic of Vietnam. 1972.

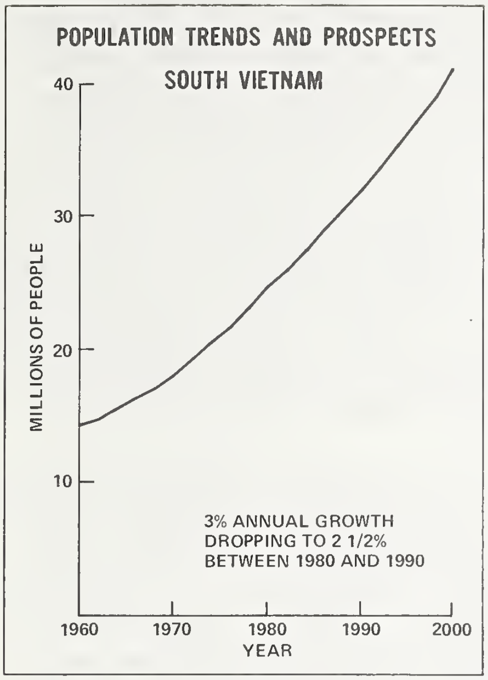

FIGURE 3

In 1960, the officially recorded cut of wood for fuel (including charcoal) was 940,000 cubic meters. By 1973, it had dropped to 79,000 cubic meters. Neither the 1960 nor 1973 estimates make any allowance for the very large unrecorded cut which was probably proportionally much larger in 1973 than in 1960. Nevertheless, there undoubtedly was a substantial decline in per capita fuelwood consumption in that period. Increased concentration of people in cities and availability of petroleum fuels because of the American presence have resulted in a significant switch to nonwood fuels.

This trend will probably be reversed. South Vietnam has more than 5 billion tons of low-grade coal and a potential hydroelectric capacity 34 times greater than presently developed. 7/ There are encouraging prospects for offshore oil production. However, the high cost of developing these energy resources, growing industrial need for power, and movement of people back to the countryside as security improves all make it likely that the total dependence on wood for fuel will increase. This, in fact, is already happening. In the first quarter of 1974, as a result of the energy crisis, the consumption of kerosene dropped 80 percent and the production of fuelwood and charcoal increased dramatically.

Fuelwood production figures tend to be crude in most nations and very questionable in some. A review of available information for a number of countries suggests, however, that recent Vietnam fuelwood production estimates provide no basis for planning future consumption. Vietnam's 1970 per capita fuelwood consumption is compared with that of Cambodia and Thailand below:

Country	Cubic meters
Cambodia	.48
Thailand	.42
Republic of Vietnam	.0065

Source: Derived from Yearbook of Forest Products. Food and Agriculture Organization of the United Nations. 1972.

7/ American Chamber of Commerce in Vietnam bulletin. March 25, 1974.

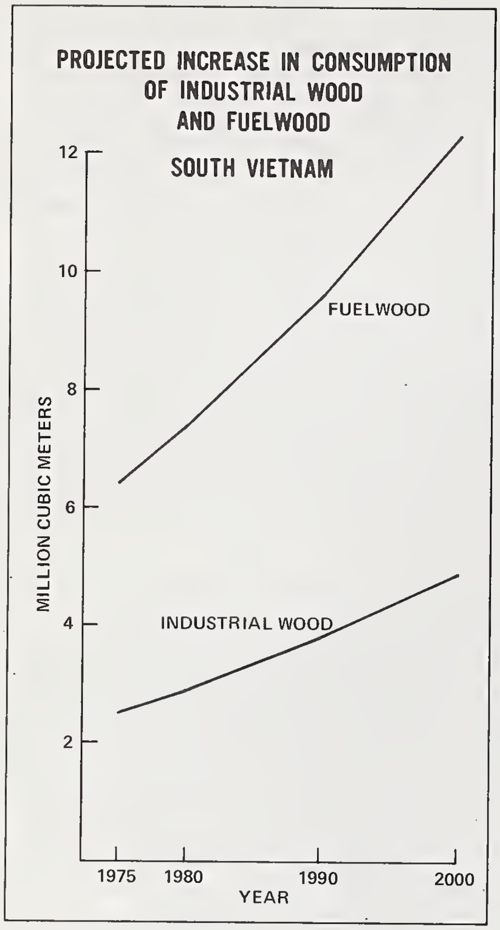

FIGURE 4

Vietnam's per capita consumption of wood for fuel in 1970 was undoubtedly much greater than indicated, but less than reported for Cambodia and Thailand. Allowing for the possibility that South Vietnam may be able to continue to take greater advantage of other fuels than some countries, we have assumed a per capita annual consumption of 0.3 cubic meters in the next several decades. If this demand materializes, the total consumption of fuelwood will climb to over 12 million cubic meters in the year 2000 (Figure 4).

The reported consumption of industrial wood (i.e., lumber and other nonfuel products) has likewise been low in South Vietnam. In 1960, the officially recorded cut of sawlogs was 319,000 cubic meters. In 1971 it was 700,000 cubic meters, climbing to 746,000 by 1973. We say "officially recorded," because there has been a large illegal cut that has not entered the records. Some observers estimated that the actual timber cut for industrial wood in recent years has been 50 to 100 percent higher than the reported numbers. This does not change the fact, however, that South Vietnam is using far less lumber, plywood, and other industrial wood, per capita, than its neighbors. Following is the reported per capita consumption in Cambodia, Thailand, and South Vietnam in 1970:

Country	Cubic meters
Cambodia	.11
Thailand	.15
South Vietnam	.04

Source: Derived from Yearbook of Forest Products. Food and Agriculture Organization of the United Nations. 1972.

Per capita industrial wood consumption in 1970 was 12 times greater in Singapore and 45 times greater in Japan than reported for South Vietnam.

Wartime conditions have, of course, discouraged civilian consumption. Moreover, the large volume of lumber and plywood brought in by the American

fighting forces was not included in the statistics, not even the portion which eventually found its way into civilian construction. Making allowances for these factors, South Vietnam still does not rank high as a consumer of wood. This is no doubt partly due to the lack of durability of many tropical woods and the absence of a technology to make wood products abundant at low cost.

If timber supply and economic conditions permit, it seems likely that this will change and that industrial wood will play a bigger role in economic development than it has in the past. The broad utility of wood as a structural material is matched by a production advantage that should become more important as time goes on. As indicated in the tabulation below, 4-1/2 to 12 times as much energy is required to build with other materials as with wood:

Type of construction	Kilowatt-hours (thermal) per square meter of wall
Wood (2"x4" - 16 inch spacing)	15
Aluminum (2"x4" - 24 inch spacing)	155
Steel (2"x4" - 24 inch spacing)	72
Concrete block (8 inch)	112
Concrete (8 inch)	176

For the purposes of planning it would be a mistake to assume that South Vietnam will need any less than 0.12 cubic meter of industrial wood per capita, per year. In such a case the national consumption will climb from about 1 million cubic meters in 1973 to almost 5 million in the year 2000 (Figure 4).

EXPORT OPPORTUNITIES

South Vietnam can look forward to a greatly increased outside demand for her timber products. The country is entering the forest products export business at an opportune time, as world markets have never been better. In a previous publication, we pointed out that the world is beginning to experience timber shortages. 8/ Demand for tropical hardwoods increased 85 percent between 1955 and 1968 and is expected to double the 1968 level by 1985. Pressures on the supply have caused timber product prices to rise dramatically in the Far East. In Japan, for example, the price index rose from 100 in 1965 to 250 in January 1974. Japan's overall price index rose from 100 to 158 in the same period (Figure 5).

8/ Export Opportunities for Vietnam Timber Products in Japan, Korea, Taiwan and Singapore. FDD Field Report 42. Economic Research Service, U.S. Dept. of Agriculture, in cooperation with U.S. Agency for International Development. Feb. 1974.

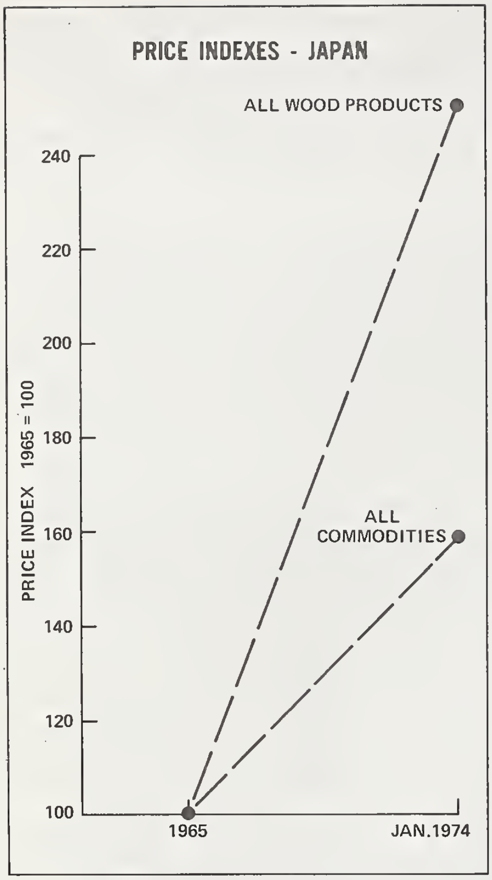

FIGURE 5

As this is written in April 1974, the price of Southeast Asian logs continues to rise despite the economic setback caused by the energy crisis. This is partly due to the fact that Japan's demands for Southeast Asian wood have not slackened appreciably. Purchase of Southeast Asian logs by Japan in 1974 is expected to exceed the record level of 1973.

The strength of prices can also be attributed in part to the minimum price controls established by the Indonesian Government (called "check prices"). For example, the check prices on exported logs for April-June 1974 are as much as $14 per cubic meter higher than they were during January-March. The average increase is probably $3 or $4 per cubic meter. Similar trends are evident in South Vietnam. An extreme example is Ven Ven logs (Anisoptera species) which were selling for $55 per cubic meter, f.o.b. Vietnam, in October 1973. Six months later these logs were being quoted at $80.

The outlook has its shadows. Shipping costs are beginning to climb as fuel, labor, and construction costs mount. This may dampen the timber boom and cause wood prices to drop. The main demand for Southeast Asian wood is for species not abundant in South Vietnam. Although the many species that grow there are suitable for a wide variety of products, the demand for South Vietnamese timber is grossly unbalanced. The bigger, higher quality trees of the more valuable species are being sought while the large volume of other species and smaller sizes are presently unwanted. There is a big market development job to be done.

Despite the difficulties that lie ahead, growing world demands for wood and the difficulty of meeting these demands make the long-run market outlook favorable. The next question, then, is the capacity of Vietnam's forests to meet increased domestic demands and to supply wood for export. The possibilities fall between two extremes: the outlook with continuation of present controls and practices, and the potential with intensified timber management and utilization.

SOUTH VIETNAM'S TIMBER SUPPLY OUTLOOK WITH PRESENT CONTROLS AND PRACTICES

In 1945, Pierre Gouron noted the rapid exhaustion of forests in the south end of South Vietnam (Cochinchina) and the disappearance of sao (Hopea spp.) in that area. The more valuable species have, in fact, been disappearing from many parts of the forest, even though the total cut has been relatively small. Any substantial expansion of the timber cut can accelerate that trend with explosive swiftness. In the absence of any more control, direction, and management than the forests have received in recent decades, more and more species will disappear from the market and liquidation of the forest will have run its course in a few decades.

To see where the mounting drain on the forest for industrial wood might lead if there is no improvement in practices, the timber resource has been projected to the year 2000. If the timber cut is increased five-fold by the end of the century; if forested areas are cleared indiscriminately for shifting agriculture; if fires burn unchecked; if there is little or no timber management; and if industrial utilization continues to be spotty and wasteful, the available merchantable resource will disappear. Sometime between 1990 and 2000 the merchantable trees (50 centimeters in diameter and larger) on the industrial timber area will have been virtually depleted (Figure 6). However, even in the absence of a forestry program, there would be considerable volume remaining in smaller trees. The next step in such a situation would be to start using these smaller trees, and they too would quickly disappear. It is futile to hope to sustain a very much larger output of lumber, plywood, and other products than in 1973 if no more effort is put into forestry than in recent years. 9/ This projection must be regarded as largely diagramatic because of the lack of accurate data. Even so, there can be no doubt of the downward trend, the only question being how rapidly the merchantable resource will disappear.

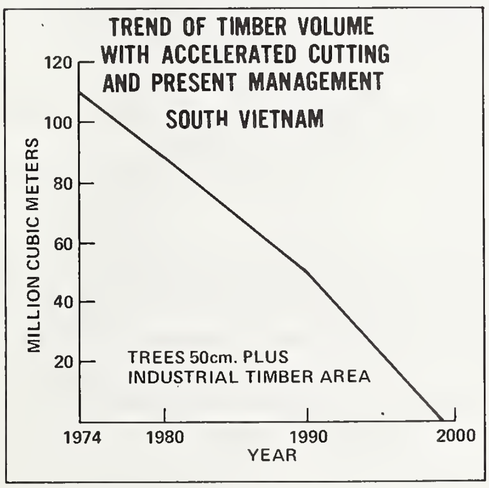

FIGURE 6

The better timber would be exhausted first. The large size pine logs being exported will be cut out in a decade or less at the present rate. With accelerated cutting, the preferred hardwood logs of larger size will be gone in a similar period.

9/ Figure 6 is based on the optimistic assumption that the very large fuelwood needs we have forecast can be satisfied without using trees that are usable or potentially usable for industrial products. Fuelwood use in the forested area would be confined to tops, branches, and small trees not required for growing stock. This will be discussed later.

The situation is not unique. A recent report from West Malaysia points out: "The supply of high grade logs to those industries which purchase their supply on the open market will reach a point of serious depletion in the immediate future." 10/ From Thailand comes the statement: "Most forests were destroyed or severely damaged during the last 20 years." 11/

SOUTH VIETNAM'S TIMBER SUPPLY OUTLOOK WITH INTENSIFIED TIMBER MANAGEMENT AND UTILIZATION

The dismal picture in the preceding section is essentially a record of what is happening projected to a conclusion. This chapter will consider what might be done with intensive forestry, greatly improved utilization, and tight management control.

GROWTH POSSIBILITIES

Vietnam's forest land has an inherently high growth capability. As in the tropics everywhere, South Vietnam is favored by almost year-long growth. Moreover, the cycle of wet and dry seasons prevailing in most of the country constitutes a favorable factor from a timber growth as well as a logging standpoint. The problem of unwanted and obstructing vegetation is relative, of course, but it appears less severe than in areas dominated by rain forest. There, the luxuriant growth of vines, shrubs, and undesirable trees represents formidable competition, making forestry both difficult and expensive.

A common estimate is that natural stands in South Vietnam will produce timber at the rate of one cubic meter per hectare per year if protected and managed properly. Considerably higher yields can be obtained from planted stands because of more complete utilization of space. Table 1 indicates appropriate rotations and annual growth rates for seven species groups. Teak is not native to South Vietnam, but it is included because previous plantings indicate it does well there.

The figures suggest that, even with some slippage, 1.5 million hectares planted to fast growing species should produce 10 to 12 million cubic meters of fuelwood annually. Likewise, 7 million hectares of industrial forest, half reproduced naturally and half reproduced by planting, should, in the long-run, have no difficulty supplying 18 million cubic meters of wood annually. These estimates seem particularly modest in light of yield estimates for planted stands that are thinned (Table 2).

10/ Forest Industries Development-Malaysia. Tec. Rept. #4. United Nations Development Programme, Food and Agriculture Organization of the United Nations. 1971.

11/ Forestry Development Project, Forest Plantation in Northern Thailand. Royal Forest Dept., Ministry of Agriculture and Cooperatives. Jan. 1973.

Table 1.--Rotations and growth rates for planted stands of seven species groups in South Vietnam

Species group	Rotation years	Annual yield per hectare
		Cubic meters
Luxury woods:		
Rosewood	100	2
Teak	50	8
High utility construction woods:		
Dipterocarps	60	4
Pines	50	6
Fuelwood and pulpwood species:		
Eucalyptus	40	10
Casuarina	10	8
Mangrove	10	15

Table 2.--Theoretical yields per hectare in planted stands

	Teak	Fast growing structural species	Pine pulpwood	Broadleaf fuelwood and pulpwood
	Cubic meters			
First commercial thinning	24.30	4.75	1.76	3.54
Second thinning	95.00	17.04	8.90	24.13
Third thinning	124.66	71.65		
Final cut	475.57	302.37	65.00	88.75
Total	719.53	395.81	75.66	116.42
Annual yield	12	13	6	12
	Years			
Final harvest age	60	30	12	10

Source: Forestry Development Project--Forest Plantations in Northern Thailand. Royal Forest Department, Ministry of Agriculture and Cooperatives. Jan. 1973.

UTILIZATION REQUIREMENTS

South Vietnam cannot capitalize on its forest potential unless all or nearly all of the timber growth is utilized, in contrast with the present highly selective utilization.

There are from 200 to 300 tree species native to South Vietnam that grow to a size and shape appropriate for one product or another. The number of species and the variety of properties they possess constitute handicaps to full utilization, not because many are unusable but because the properties of some are not fully known, because wood users prefer to stick with the few tested species with which they are familiar, and because no single type of mill can make effective use of all the properties. The past lack of market acceptability of many species and the general tendency to utilize only the largest trees has severely handicapped timber utilization.

The situation has been improving. A number of species are now being used for nonfuelwood purposes that were formerly passed over. Smaller trees are being utilized in some cases. An example is nong heo (*Holoptera intergrifolia*), a species not even included on many recent lists. Nong heo, characteristically a small tree, is now in some demand as a substitute for ramin (*Gonystylus bancanus*).

A tentative summarization of species suitability in Vietnam is included as Appendix C of this report. The product opportunities are wide, ranging from archery bows to millwork to railroad ties. Moreover, there are a number of species suitable for most uses. This list certainly constitutes no final answer to the question of suitability, but it provides ample proof of the breadth of product utility of Vietnamese forests. Research is essential to document the properties and interchangeability of species occurring in significant quantities in Vietnam. Such information would help direct each species to its highest value use.

Two basic products, particleboard and plywood, are quite nonrestrictive in their demands and could use many species. As a reconstituted wood product, particleboard can be made from almost any tree; the heavy weight of chips of some species can be offset by mixing them with the chips of lighter species. Most species with 0.4 specific gravity and over can be peeled into veneer and used as either core or face sheets in structural plywood. Of 118 Vietnamese species for which specific information is available, only 5 had a specific gravity less than 0.4. Some of the lighter woods can be used for other types of plywood.

To achieve a high degree of utilization, a broad industrial base will be necessary. For example, if a forest is logged only for lumber, a large part of the volume in tops, limbs, small trees, cull trees, and secondary species is usually left behind as waste. At the other extreme, if all the cutting is for pulp, part of the possible revenue from trees suitable for higher value products is lost. Wood shortages have forced importing countries such as Taiwan and Japan to make very complete use

Figure 7. Logged over Dipterocarp forest. If protected from fire, this open forest reproduces quite well.

of the logs they import. Unless the wood-producing countries such as South Vietnam can secure integrated product utilization in their manufacturing operations, much of the industrial potential will be lost--and maybe the economic feasibility of timber production on some areas as well.

PHYSICALLY OBTAINABLE YIELDS IN THE NEXT FEW DECADES

That South Vietnam has the forest growth capability to meet its own timber requirements in the long run there can be no doubt. The difficult question is whether escalating timber product needs in the next several decades can be met without seriously depleting the forest growing stock. Setting aside economic desirability and political feasibility, we can demonstrate, however, that it is possible with an aggressive and highly disciplined program to meet the mounting domestic requirements for lumber, plywood, poles, and other industrial wood products and at the same time increase timber product exports.

To do this would require full utilization of species, maximum coordination of utilization among industries, adequate protection from fire and other destructive agents, and tight control of activities in the forest. The key strategies in a program to do this would be heavy liquidation of the existing merchantable stands, accompanied by large-scale planting as soon as possible to replace the trees removed.

In Appendix A, the timber yields have been projected to the year 2000 under a program of intensive management and full utilization. This program contemplates logging 92,000 hectares annually. All of the volume would be removed from 69,000 hectares and new stands established. The other 23,000 hectares would be selectively logged. How many of the clear cut areas would have to be planted is a moot point, as in dipterocarp stands reproduction is fairly abundant if fires are kept our (Figure 7). It seems safest to assume that 69,000 hectares of clear cut or partially cut forest would have to be planted to some degree each year. Also, 50,000 hectares of presently deforested area would have to be planted to industrial timber species annually. This catch-up program would restore one million hectares over a 20-year period.

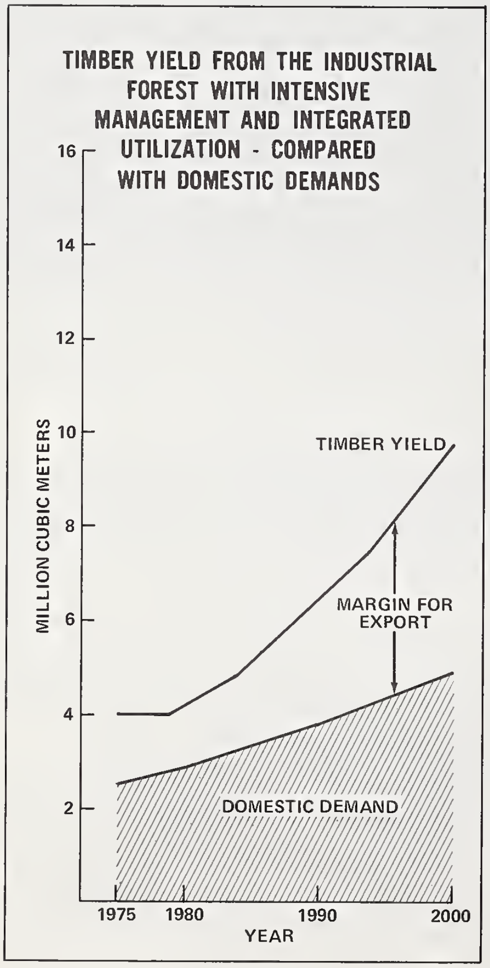

FIGURE 8

If these rigid requirements can be met, the annual commercial timber cut could be jumped to 4 million cubic meters in the near future, climbing to 10 million cubic meters by the end of the century (Figure 8). Timber product exports could be immediately raised from 237,000 cubic meters in 1973 to more than 2 million cubic meters annually. Exports could climb to 5 million cubic meters annually by the end of the century.

THE INCOME POTENTIAL

The real value of wood has risen in recent years along with the values of gold, silver, oil, and other raw materials which are becoming scarcer. For the purpose of calculation, we have assumed that the real value of wood products will increase 50 percent between 1974 and 2000, and also that South Vietnam will eventually cease to export logs and ship its wood out in manufactured form. If these assumptions prove correct, the total value of timber products output would exceed $1 billion annually (1973 dollars) by the end of the century as compared with something over $100 million now. More dramatically, timber product export values would climb from $13 million to more than a half billion dollars (Figures 9 and 10).

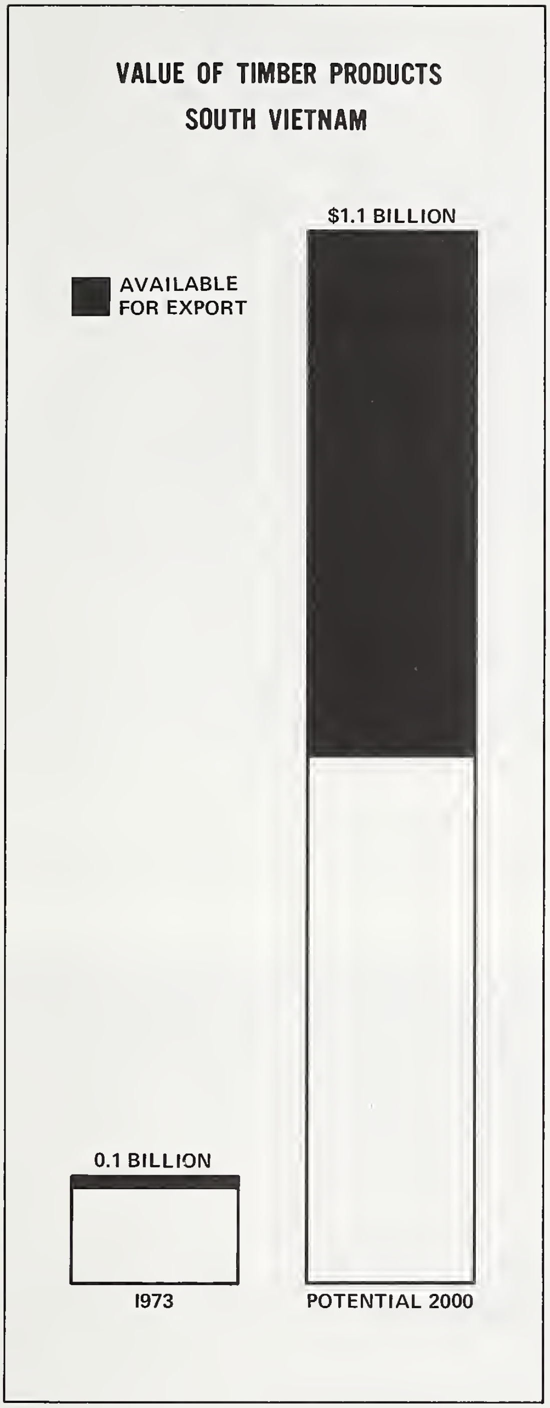

FIGURE 9

THE BOLD ASSUMPTIONS

The point needs to be underlined that these yield and value accomplishments will require extraordinary effort and discipline and a complete reversal of past trends. As an example, the planting program that seems necessary is staggering by past standards and would, in fact, be a massive effort to restore productivity lost through centuries of neglect and abuse. As already mentioned, it seems reasonable that some degree of planting (complete planting or fill-in planting) may be required on 69,000 of the hectares cut over annually. In addition, it makes sense to undertake a crash program to restock 1 million hectares of presently deforested area with commercial species such as teak, ven-ven, and pine in the next 20 years. It is no less necessary to combat fuelwood starvation with a large planting program of species suitable for this purpose. We are suggesting that another 1 million hectares should be planted to fuelwood species over a 10-year period, with the knowledge that, if all of the wood is not required for fuel, it would be suitable for pulp and light construction.

These planting efforts would add up to more than 200,000 hectares annually for the first decade, dropping off in stages after that. Compared with the 5,500 hectares planted in 1973 or even the 50,000 hectares of planting planned for 1977, this is an enormous task. Planting at the annual rate of 219,000 hectares would cost about $23 million annually. Subsequent maintenance and protection of this area of plantation would cost another $5 million.

The Directorate of Waters and Forests has recently prepared fairly ambitious plans for timber regeneration. We are suggesting that, if timber products are to be a vital factor in South Vietnam's struggle for survival and economic security, far larger forestry programs should be considered.

Figure 10. Forest product exports from Vietnam. Above: rosewood logs destined for Japan at $245 per cubic meter, f.o.b. Below: pine and ven-ven lumber packaged for export.

THE FEASIBILITIES

In weighing the possibility of achieving the high production levels we have discussed, account must be taken of industrial feasibility. Account must be taken also of the feasibility of the major forestry effort which would be necessary. The most important factor of all, however, is the question of whether it is possible to obtain effective planning, a national commitment to a very large forestry development program, and a continuity of effort over a long period. This, for the lack of a better term, might be called "institutional feasibility."

INDUSTRIAL FEASIBILITY

South Vietnam probably should never hope to develop the manufacturing economies arising from large-scale operations such as some big concerns in Korea and Japan now enjoy. It may not be able to secure equally low shipping rates for exported manufactured products, either. However, South Vietnam does have some important advantages. One of these advantages is that it has a timber resource of its own and does not have to import logs.

Timber products manufactured for export by Taiwan and Korea bear extra handling charges in the cost of shipping their logs from Southeast Asian countries. In the fall of 1973 this shipping charge was $6 to $8 per cubic meter to Taiwan and typically $8 to $13 to Korea. The cost of ocean shipping has since risen sharply, primarily because of the big jump in fuel oil prices. At present no one can say at what level shipping costs will stabilize, but they are likely to be an increasing burden to countries importing logs for export products.

Over the years Japan successfully resisted pressures to import more manufactured wood products. However, circumstances are beginning to force a change. Inability to get all of the logs it wants and rising labor costs in Japanese mills are forcing greater imports of lumber, plywood, and other manufactured or partially manufactured products. In this connection, South Vietnam, for the present at least, has a sizable advantage. An unskilled millworker in South Vietnam earns less in a day than his counterpart in Oregon earns in an hour. Even in comparison with the major timber manufacturing countries in the Far East, worker income in South Vietnam is very low. Accurate averages simply are not available, but the data in table 3 indicate in a general way the relationship of incomes in Japan, Taiwan, Korea, and South Vietnam for sawmills and plywood mills.

Table 3.--Comparative wage rates--monthly income

Country	Unskilled labor	Technicians and foremen
	U.S. dollars	
Japan	281	350
Taiwan	65	150
Korea	60	---
South Vietnam	30	80

As with other countries further along in their development, the wage advantage will gradually diminish as the local economy becomes stronger. However, for the coming few years, at least, low wages and salaries will enhance the profit opportunities for new plants. Plant site costs tend to be low. In most cases, South Vietnam will provide the necessary space on a 99-year lease at nominal fee. Offsetting this is the fact that water and power are expensive in Vietnam, and are likely to be for some time to come. Construction costs are apparently neither high nor low, but, because most of the equipment will be coming from overseas, very large inventories of spare parts will be necessary to minimize prolonged shutdowns for repairs.

These pros and cons indicate reasonably attractive investment opportunities once security conditions improve sufficiently to assure a steady flow of logs. We have examined the investment of four different sawmills with lumber production ranging from 6,000 cubic meters to 33,000 cubic meters annually and requiring an investment of $279,000 to $1,126,999. A large part of the investment in each case is for working capital. Long distances from major markets and from equipment companies require sufficient capital to survive under circumstances of slow payment and a relatively large amount of money tied up in spare parts. Despite this, the prospects are financially attractive. The largest sawmill considered would pay back the investment in 2 years and the smallest in 3-1/2 years, as shown in the sawmill investment opportunity comparisons on the next page. The details of these investment analyses are presented in Appendix E.

To gain economies of scale in plywood manufacture, large plants such as those in Korea would be desirable. However, until there is more accurate information on the amount and distribution of the timber resource, it seems prudent to stick to smaller size plants in South Vietnam. For the purposes here, investment opportunities have been analyzed for a rotary plywood plant costing nearly $3 million and consuming 50,000 cubic meters of logs annually. Financial evaluations have also been made for a sliced veneer plywood plant utilizing half the volume of logs but requiring an investment that is almost as large ($2.4 million). Both plants would pay off the investment in about 3 years. (See data on page 22.)

Investment opportunities in sawmills

Sawmill #1

Annual log consumption	9,000 cubic meters at $\$40/m^3$
Annual lumber production	6,000 cubic meters at $\$85/m^3$
Plant and equipment cost	$151,500
Working capital	127,500
Total investment	279,000
Profit returns on sales	16%
Annual profit return on investment	29%

Sawmill #2

Annual log consumption	15,000 cubic meters at $\$40/m^3$
Annual lumber production	10,000 cubic meters at $\$85/m^3$
Plant and equipment cost	$182,483
Working capital	212,500
Total investment	394,983
Profit return on sales	20%
Annual profit return on investment	42%

Sawmill #3

Annual log consumption	18,000 cubic meters at $\$40/m^3$
Annual lumber production	12,000 cubic meters at $\$85/m^3$
Plant and equipment cost	$219,980
Working capital	255,000
Total investment	474,980
Profit return on sales	20%
Annual profit return on investment	43%

Sawmill #4

Annual log consumption	50,000 cubic meters at $\$40/m^3$
Annual lumber production	33,000 cubic meters at $\$85/m^3$
Plant and equipment cost	$426,999
Working capital	700,000
Total investment	1,126,999
Profit return on sales	22%
Annual profit return on investment	55%

Rotary Veneer Plywood Mill

Annual log consumption	50,000 cubic meters at $40/m^3$
Annual plywood production	25,000 cubic meters at $144/m^3$
Plant and equipment cost	$2,224,000
Working capital	762,000
Total investment	2,986,000
Profit return on sales	29%
Annual profit return on investment	35%

Sliced Veneer Plywood Mill

Annual log consumption	25,000 cubic meters at $60/m^3$
Annual plywood production	20,250 cubic meters at $144/m^3$
Plant and equipment cost	$1,700,000
Working capital	708,000
Total investment	2,408,000
Profit return on sales	33%
Annual profit return on investment	40%

The favorable situation for the sliced veneer plant is primarily attributable to the much higher rate of recovery that can be obtained by slicing. Both analyses are based on using common species. Slicing of luxury woods should be much more profitable than we have shown.

South Vietnam's two existing plywood plants are modern and would fit well into a long-range development scheme. However, few, if any, of the sawmills in Vietnam today would qualify. Most of them operate intermittently and produce a second-rate product with substantial waste (Figure 11). Some of the intermittent operation has been attributed to periodic unavailability of logs because of the continuing struggle for the forest. However, it is also partly attributable to traditional practices of sawing only on orders previously received (custom sawing).

Development of South Vietnam's timber product industries should proceed along two lines: the upgrading of the existing industry and the establishment of new, larger plants. The ultimate objective in both instances would be to get plant groupings which would make complete utilization of the available timber.

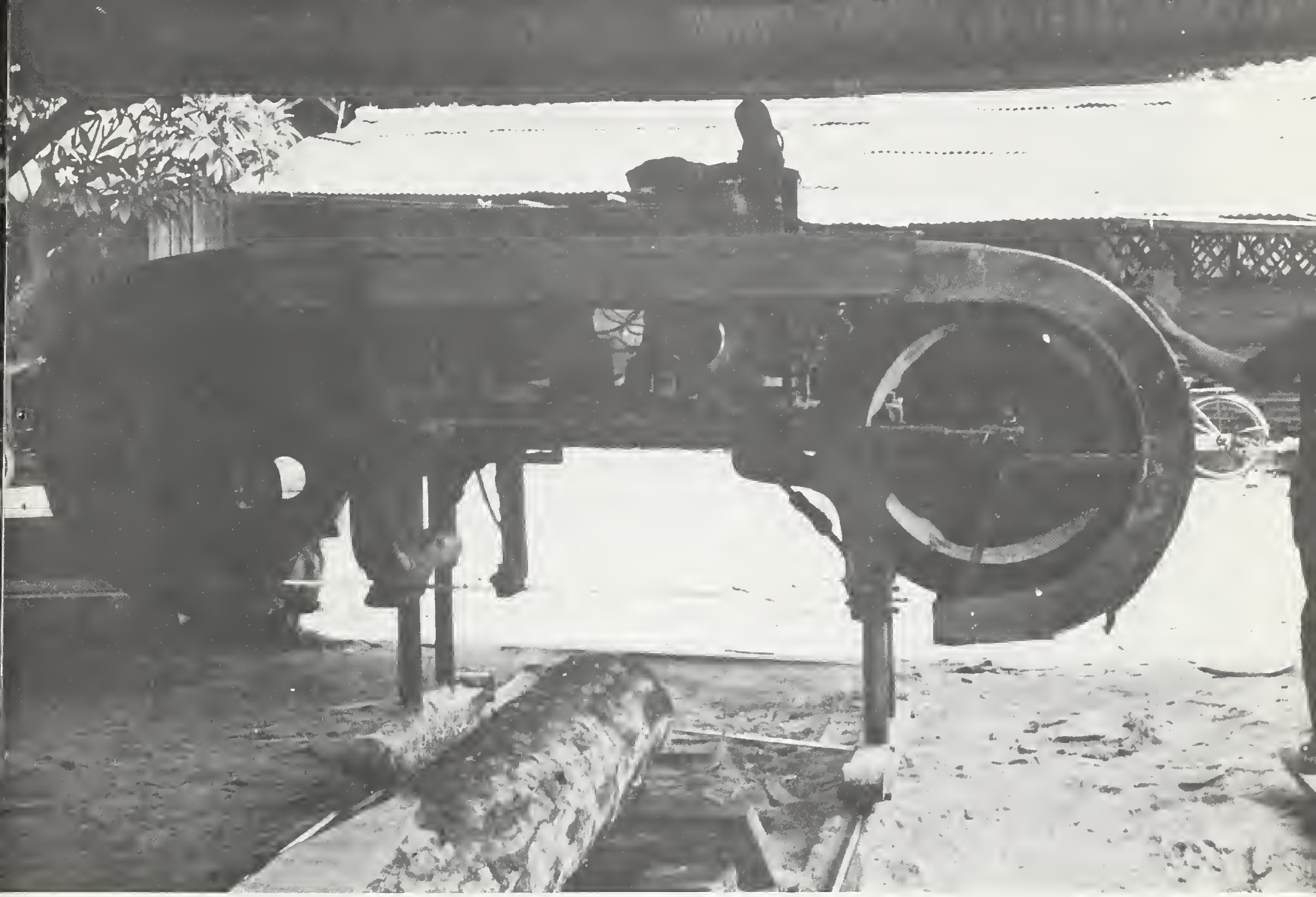

Figure 11. A typical CD-4 horizontal band sawmill. The log is stationary and the saw is pushed through it on the track. Such mills can produce very good lumber with a minimum of loss in sawdust. However, failure to keep sawteeth sharp, tracks aligned, and the mills otherwise maintained has resulted in much poorly manufactured lumber.

The Dwyer Mission in 1966 recommended a program of technical improvement to increase the lumber output from the small sawmills by 50 percent. 12/ This would involve installing support equipment consisting

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12/ Recommendations for Development of the Forest Resources of South Vietnam. Dwyer Mission. 1966.

of an edger, a dead roll lumber conveyer, and a log turner at each mill as well as training sawmill personnel to operate and maintain the equipment and assisting mill owners in revising plant layout for more efficient operations. These suggestions are still pertinent.

In addition to upgrading or modifying existing plants, a completely new and modern industry will need to be established if the export opportunities are to be fully exploited and if most effective use is to be made of the present timber resource.

High priority should be given to establishing moderate size manufacturing complexes consisting of different types of plants. The reason for this, of course, is that the diversified wood requirements of a complex provide better and more complete utilization of the timber. Rotary plywood mills can use poorer logs than sawmills. Some of the better logs are best suited for lumber and the greatest value can be obtained from the large, clear logs of preferred species by slicing.

The structure of any wood industry complex should be based primarily on the extent and nature of the timber resource available. However, in general, we are thinking of complexes made up of the moderate size plants discussed earlier plus a particleboard plant.

Facility	Size--Annual raw material consumption
Sawmill	50,000 m^3 consumption of logs
Rotary plywood mill	50,000 m^3 logs
Sliced plywood mill	25,000 m^3 logs
Particleboard plant	30,000 m^3 residue from above plants

A particleboard plant for chipping logs probably would be a marginal opportunity because of raw material costs. However, one using slabs, edgings, waste veneer, and other wood scraps in an industrial complex appears highly feasible, for a relatively small additional investment. By having the particleboard plant in the complex, the value of the output and employment would both be raised 16 percent and the rate of return on investment increased significantly (table 4).

During the past few years, considerable thought has been given to expanding the paper industry of South Vietnam by building another pulp and paper mill capable of producing 100 to 200 tons of pulp daily. This idea has a great deal of appeal because, as in all countries, there is a need for paper of all sorts, and importing paper products uses up a considerable quantity of foreign exchange. 13/

13/ According to USDA/AID adviser Robert A. Ralston and Do Cao Tho of the Directorate of Waters and Forests, at least six pulp manufacturing studies have been made in South Vietnam in recent years. Ralston and Tho do not recommend pulp mill expansion at this time. The Forestry Sector of the Economy of the Republic of Vietnam. Mimeo. USAID, Directorate of Waters and Forests. May 1970. Saigon, Vietnam.

Table 4.--Gains from a particleboard plant in an industrial complex

Item	1 Sawmill 1 rotary plywood mill 1 sliced plywood mill	Particle-board mill	Complex total
Investment required	$6,520,999	$1,030,000	$7,550,999
Rate of return on sales	38%	49%	31%
Annual return on investment	40%	70%	44%
Annual value of products	$9,321,000	$1,484,000	$10,805,000
Number of employees	395	62	457

We believe, nevertheless, that it would not be prudent to plan for such a pulp plant or plants in the first stage of development for at least a decade. There are several interrelated factors leading to this opinion. First, the potential benefit to the community per unit of wood from sawmills, plywood mills, and related plants is greater than from pulp and paper plants. While pulp and paper production is ultimately needed, there is a danger that premature construction of pulpmills might preempt timber better suited for other uses and block balanced industrial development. A pulpmill of the size required to produce 200 tons of pulp daily would need 240,000 cubic meters or more of wood annually. Without an already established lumber-plywood industry, there would be little opportunity to satisfy any of the raw material needs from plant residues. A more serious problem is the possibility that, in order to satisfy the appetite of a pulpmill, wood better suited for other purposes would have to be used.

Construction of a pulpmill tends to be one of the less reversible decisions because of the high investment required. A 100-ton pulp and paper plant producing unbleached kraft paper would cost about $21 million. A 200-ton plant would cost about $35 million. The problem is compounded by the fact that no one pulping process can meet all of the wide variety of paper needs of a country.

At one time, nearly all of the paper was produced from softwoods (conifers), whereas most of the tropical timber is hardwood. In the last few years the use of hardwood timber for pulping has increased, but the technology for hardwood pulping is still developing; this adds uncertainty that can best be coped with by the more developed countries. Unfortunately, hardwood pulp is not suitable for newsprint, the biggest single paper need.

The discussion of modern pulp mills in Vietnam tends to be academic at this time because prudent investors are unlikely to risk such large

sums of money with the virtual absence of reliable information about the amount and distribution of the timber suitable for pulping.

All in all, there are more reasons for going slowly in establishing a modern pulp and paper industry than there are for making such an investment soon. This in no way diminishes the desirability of eventually establishing a medium size modern pulpmill in South Vietnam. With so many forest species, a substantial fiber-based industry is necessary to make full use of the timber.

There has also been some interest recently in establishing a chipping plant to produce mangrove chips for dissolving pulp. The price is good and the opportunity to make a profit is great. To produce 120,000 tons of chips annually would require plant and equipment costing only $420,000. Working capital for 90 days would amount to $700,000 for a total investment of $1,120,000 (see Appendix E). Such an operation would return a 21 percent profit on sales and a 78 percent annual return on the investment. In other words, it would be possible to almost pay off the investment the first year.

The outlook may not be as bright as the figures indicate. About 240,000 cubic meters of mangrove would be required yearly to feed such an operation. This is perhaps more wood than the mangrove forests could supply without being gutted. The defoliation during the 1960's and early 1970's was more lethal to mangrove than other tree species, and there has been little or no resprouting in these defoliated areas. It is a moot point today how much suitable mangrove there is. Consequently, although the growth rates attributed to mangrove plantations (15 cubic meters per hectare per year) are very high, the possibility remains that there may not be enough of this timber to sustain a large chipping facility.

Another question is the priorities of use. With a greater need than ever before for fuelwood, careful consideration must be given to the possibility that the remaining mangrove may be more valuable for fuelwood, poles, and other products. One disadvantage of a chipping operation is that the value of the product is low, as is the employment in the manufacturing operation (not including logging). The lumber-plywood, etc., complexes discussed earlier would produce products five times more valuable than a chipping plant, and provide 18 times more employment (in the plants) from a given volume of wood. 14/

To some degree there will have to be a manipulation of the production and marketing processes for forest products to protect both domestic consumption and export opportunities. On the one hand, it will be desirable for some time to come to export the species and qualities of products that will produce the highest export values. On the other hand, as some other developing countries have discovered, special measures will be necessary to assure that wood products needed in Vietnam are not priced out of reach of domestic users by buyers for export.

14/ Mangrove forests have an important environmental role; they are spawning sites and food sources for fish. These values also need to be taken into account when considering additional industrial use of the mangrove forests.

FORESTRY FEASIBILITY

Past forestry efforts have been miniscule compared with the need. The question, then, is how realistic it is to suppose that South Vietnam could turn itself around and in a short period shift into a high gear forestry effort. If the forest resource offers one of the few opportunities South Vietnam has for economic salvation, traditional tests of economic desirability tend to be academic. Calculations such as recently made in Thailand, which show plantations of commercial timber species will return 5 percent or more on the investment, become incidental if it can be shown that these plantations can be an important factor in the survival of a Nation. 15/

The significant forestry questions are whether enough technical knowledge is available to permit doing the job adequately and whether the large forestry effort required is more than the country could handle at this time.

The level of knowledge concerning the management of tropical forests is certainly much lower than for forests in the temperate regions. There is still much to be learned about timber growing in South Vietnam; about the growth characteristics and potentials of individual species; about seed production and regeneration problems of the many species; about the limitations and opportunities set by soil conditions, particularly in areas that have been abused; about the technical and technological properties of various woods; and about many other matters relating to forest development.

Notwithstanding the need for more information, the state of existing knowledge is adequate to permit successful forest management on a greatly expanded scale. It is not likely that competent foresters would make many devastating mistakes, and there is every reason to suppose that quality of performance would rapidly improve with experience. Likewise, it should be possible with well-directed research to assemble and improve the knowledge of wood properties sufficiently to permit broader species utilization than at present.

The most serious difficulty is likely to be in increasing the number of well-trained professionals rapidly enough to maintain proper control and supervision of expanding programs. With careful planning, though, this can be done.

The high future timber yields we have projected will require a relatively large continuing expenditure of funds that must begin soon. Not enough information is available now to estimate the annual cost of a full-scale forest development program. However, the large timber stand regeneration program suggested earlier would probably cost $23 million to $28 million annually. Whether these costs are greater than South Vietnam can bear can only be judged by weighing them against other priorities,

15/ Forestry Development--Project Forest Plantation in Northern Thailand --Requested for Financial Assistance from the International Bank for Reconstruction and Development. International Development Association, Royal Forest Department--Ministry of Agriculture and Cooperatives. January 1973.

but it is worth noting that one-third to one-half of the amount required for planting is presently being drained off in the form of payoffs to Viet Cong and South Vietnamese officials alike in the process of getting the logs to the point of manufacture.

It seems likely that considerable international financing could be obtained for the forestry work. Moreover, an enticing aspect of forestry employment is that it is an effective way to provide double return. Timber planting, for example, can be handled as a continuing public works program, providing desperately needed employment and community stability in rural areas now, while setting the stage for expanded timber production and employment in the future. With present intensity of labor use, an annual timber planting program of 219,000 hectares could employ 80,000 to 90,000 persons.

INSTITUTIONAL FEASIBILITY

South Vietnam has been striving to create a desirable environment for industrial development and has, in some respects, been quite successful. The basic investment law of June 1972 exempts investors from profit taxes, real estate purchase taxes, and a variety of other taxes for specific periods, usually 5 years. It waives import duties on imported machinery, equipment, and spare parts necessary for operation of a project that qualifies under the investment law. It allows accelerated depreciation. It guarantees against nationalization and allows profits earned by foreigners to be taken out of the country without restriction. These and other investment terms appear to be generous and are said to match those offered by any other developing nation.

In actual application, unfortunately, the investment law has been something of a disappointment. The typical company seeking to start out in business in South Vietnam is literally swamped with frustrations. Decisions and clearances become stranded in a bureaucratic jungle. It is not that any of the decisions and clearances are unnecessary; the problem appears to lie in fragmented authorities and lack of unity of purpose among agencies. The difficulties encountered are probably normal growing pains in a country that does not have the time to evolve slowly. In any case the main roadblock to successful timber development is the difficulty of getting incisive governmental action.

The Directorate of Waters and Forests, which has the principal responsibility in this field, lacks the stature, authority, and freedom of action required to get any job done well and quickly. Neither is it organized to handle greatly enlarged responsibilities. For this reason, any decision to give timber development a high priority in the national program should be followed with careful consideration of ways to strengthen the capacity of the government to lead the planning and to provide the control and supervision required.

One of the more obvious impediments to orderly business is the "payoffs" which have become quite burdensome in South Vietnam. There are, of course, wide variations, but one informant cited the following

costs per cubic meter of saw logs delivered to Saigon in the fall of 1973:

Stumpage	$2.50
Local taxes	4.00
Logging and hauling to yard	7.00
Transport to port from point of manufacture	10.00
Illegal payoffs to officials	5.30
Viet Cong payoffs	8.00
20 percent profit	7.40
Total	$44.20

The payoffs in this case amount to about 30 percent of the end price.

The present situation with regard to the payoffs required to conduct business is symptomatic of the deeper problems that will make it difficult to get an effective national commitment to forest development, plus sufficient unity of action and continuity of effort. The real challenge will therefore be to achieve a considerably higher degree of institutional effectiveness in the near future.

SECONDARY INDUSTRY

South Vietnam has many little furniture shops, but it does not have a modern mass-production furniture plant. There is likewise no modern planing mill, moulding factory, or lumber laminating establishment in the country. All of these will be needed in the reconstruction of Vietnam. In addition, well-manufactured furniture and furniture parts can enter the world market. Foreign companies have expressed an interest in the possibilities and, with the return of stability, there is likely to be considerable development along these lines.

The big immediate market is the domestic one. For example, an earlier analysis by the Directorate of Waters and Forests and USAID points out that the demand within South Vietnam for school desks alone can exceed 300,000 sets annually. 16/ The total potential market within South Vietnam for all types of furniture, mouldings, flooring, and similar items is undoubtedly large, representing an important industrial need.

These secondary manufacturing industries are significant for three reasons. They use material locally available, ranging from ordinary woods to the most select, valuable species. For the most part they are labor intensive industries that stretch the employment provided by the timber resource. Data from Singapore, for example, indicate that about 20 people are employed for every 1,000 cubic meters of lumber annually

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16/ A Drykiln, Mass Production Furniture Plant and Planer and Moulding Plant in the Saigon-Bien Hoa Area. Prepared by Directorate of Forests and Waters, Republic of Vietnam, and MLRFD and Industry Division/USAID/Vietnam. December 1971.

consumed by the furniture plants. Thirdly, South Vietnamese have the artistic ability and craftsmanship required for such enterprises. This is emphasized by the fine lacquerware and other handicraft products now being exported. Products differ greatly in labor requirements, but we can, in general, expect the income and employment per unit of wood in the manufacture of furniture and other secondary products to equal that provided in the sawing, peeling, and slicing of logs into primary products. Thus, while first attention must be given to developing an adequate forestry program and a balanced primary industry, attention should also be paid to the opportunities for expanding secondary manufacture.

There is a pressing need to upgrade the industry as secondary manufacturing develops. There are notable exceptions, but many of the small furniture shops waste high-quality wood with poor quality products. It is a serious waste when fine rosewoods are used in cheaply constructed furniture that will bring minimum prices. If South Vietnam is really to penetrate the world market for furniture and other small manufactured items, it will need to develop quality controls.

A DEVELOPMENT PROGRAM

One may ask how realistic this discussion of forestry opportunities is. Are the opportunities realities or mirages?

There can be no doubt that South Vietnam has more forest land than anything else. Nor is there any doubt of the large productive capacity of this land. It is also very apparent that the country will need all of the income and raw material the forest land can provide. As we have already pointed out, the critical issue is whether South Vietnam can develop the commitment, unity of purpose, dynamism, and continuity of effort required.

GOALS

The first step is to establish national policy as to what place forest land management and timber development are to have in stimulation of future economic growth. How heavily will South Vietnam rely on the forest for raw material, employment, and income? What priority will forestry development have in economic recovery efforts? Until there is a firm national commitment in this regard, the planning needed to develop the forestry potential will be erratic and inconsistencies and waste will occur in the programs.

LAND USE PLANNING

The second step should be to determine what future land-use patterns are to be. Primarily this is a matter of deciding which areas are to be developed for permanent cultivation and grazing, which areas for shifting slash-burn agriculture, which for timber growing and watershed protection, and which for other uses. The identification of land capabilities and land-use objectives is particularly urgent in the case of timber. The boundaries

of the timber growing areas must be firmly established and guaranteed through protection from encroachment.

No doubt one of the most difficult tasks will be to reach a reasonable accommodation between shifting agriculture and timber growing. This may require both curtailment of timber growing objectives and a gradual phase out of slash-burn agriculture. In the long run it must involve severe restraint of shifting agriculture in areas to be used for timber growing.

Land-use classification is a progressive process that requires time to refine. It is essential, though, that the broad framework of future land use be established as quickly as possible using satellite pictures or other means to make the primary land-use decisions. The refinement process must also be carried out as rapidly as possible with soil surveys and other inventories.

Reliable timber inventory information is required to give a more accurate picture of the timber development problems and opportunities than we have been able to present here. In this instance, also, the first step should be a broad reconnaissance survey, by experienced foresters, of the types of forests, timber sizes, reproduction problems, soil capabilities, management options, and other items necessary for better conceptualization of the opportunities and problems in the development of a broad management strategy. Currently, a very general description of the forest in each province is being compiled from aerial photos. This will be helpful as a starter.

A DEVELOPMENT STRATEGY

Operation of a 7, 8, or 9 million hectare forestry enterprise and the design and development of a desirable industrial structure are both enormous and complex tasks which would strain the management of a large corporation. If the many things that have to be done right are to be done right, master plans or blueprints for action must be developed as quickly as possible. Such matters as the type of organization required to guide the development, priorities of action, how to streamline the decision-making process, development of the most useful contractual arrangements, and many more questions must be considered carefully to provide policy, program, and operations guidelines.

It is for this reason that one of the most urgent, difficult, and demanding tasks ahead is the preparation of plans and guidelines for achieving the announced national goals.

OBTAINING STRONG SUPERVISION

At present, the Directorate of Waters and Forests is a subordinate government agency lacking both the authority and the muscle required to handle the kind of program we have been describing. To carry out such a program will obviously take strong, aggressive leadership with sufficient authority to cut unnecessary red tape and to get things done. Just how the authorities needed should be allocated is a matter beyond the scope of

this study. It is apparent, though, that unless those in charge of forestry development are given enough administrative leverage, the best of men and the best of plans will be frustrated.

DEVELOPING TECHNICAL CAPABILITY

Like all developing countries, South Vietnam is handicapped by a shortage of skilled manpower and technical knowledge. There is a thin layer of well-trained foresters on top, but none of the depth required for successful operation of a large program. Any decision to expand forest development should be followed by a program to increase the number of trained professionals and to establish training programs for the thousands of technicians who will be required for day-to-day supervision of the forestry activities. Such skills as species identification, planting techniques, nursery practice, and fire fighting methods will have to be taught on a wholesale basis. This training effort is one in which the Food and Agriculture Organization of the United Nations and the international aid programs of several countries could be helpful.

The modest forestry research effort in South Vietnam would have to be accelerated at the same time, with initial emphasis on silvicultural practices, regeneration methods, and wood properties. The forestry agencies of several of the developed countries could be helpful in laying out such a program, which should begin by collecting as much literature as possible regarding relevant past research in these fields.

FOREIGN ASSISTANCE

South Vietnam will need all of the help it can get, for the task of building a strong forest economy is very large. Fortunately, the prospect of world shortages of raw materials has recently made developed nations more conscious of the vital interdependence between them and the developing countries. This new awareness should gradually result in changed attitudes and less exploitive tactics. There seems to be growing willingness to work with the developing nations. This new posture is most apparent in the case of Japan, which is critically dependent on imports for survival. Two recent official documents from Japan have stated an interest in helping its neighbors with forestry and timber industry development. 17/ Taiwan has indicated the same desire in a less formal way.

17/ Economic Cooperation Through Development of Forest Resources. Forestry Agency, Ministry of Agriculture and Forestry, Japan. May 1973. Basic Plan Regarding Forest Resource and Long Range Prospects Regarding Demand and Supply of Important Forest Products. Ministry of Agriculture and Forestry, Japan. February 1973.

The only problem has been the highly exploitive past performance of many overseas companies. However, in Japan's case, Prime Minister Tanaka has promised that the Government would exercise greater control of practices by its companies overseas. *Time*. January 21, 1974.

There are three possibilities. One, of course, is financial assistance to forestry and industrial development programs. Another is direct forestry advice and technical assistance. Third is help in making the timber concessions currently being planned completely successful by assuring that the industrial and forestry activities are carried out as planned. It will be both necessary and desirable to have foreign companies participate in the timber development, either independently or as partners in joint ventures. Two such long-term timber leases with a total area of about one-quarter million hectares are currently under consideration. If they and the subsequent ones are set up in the manner proposed, the development contracts should require relatively complete utilization of the species in the natural forest, the construction of a variety of industrial plants to make best use of the timber, care of the environment, and a full-fledged forestry effort. During the early years, at least, it will be difficult for the Government of South Vietnam to adequately enforce such contracts by itself. It is for this reason that the possibility of tying foreign aid into the contracts be considered. For instance, the Japanese Government might focus some of its foreign aid in a timber lease held by a Japanese concern, providing technical help in accomplishing the forest management, improving the quality of utilization, and also assuming some responsibility for the quality of performance of the leases.

IMMEDIATE STEPS

Full development of the forest will have to wait until the area back from the roads and settlements is considerably more secure than it is today. Continued fighting in the forest will frustrate the forestry effort and make it impossible to achieve adequate control. However, the present military impasse should not be allowed to delay the establishment of goals or the initial stages of land-use planning. Blueprints for whatever long-range program is agreed upon need to be prepared as soon as possible, along with necessary organizational changes.

Fortunately, the military situation does not preclude all forestry effort at this time. There are about 2 million hectares of deforested forest land along the coast. Militarily speaking, this a relatively "secure" area that can be worked in safely. We suggest that two large-scale tree planting programs be undertaken as quickly as possible. In the case of fuelwood (or pulpwood), the planting should be build up to 100,000 hectares annually for 10 years, after which the first of the planted stands should begin to be harvested. Some of the trees should go into farm woodlots, but the bulk probably should be used to establish extensive fuelwood forests, putting large stretches of idle land to work.

Teak, ven-ven, and other species of value, plus fast-growing woods suitable for structural purposes, should also be planted on a somewhat smaller scale. In this case, another million hectares should be planted over a 20-year period, or 50,000 hectares annually. The average rotation of these industrial woods would be about 50 years, but commercial thinnings could be made before that.

As we have pointed out, plantations hold the key to success in building up the country's timber productivity. It follows, therefore, that the quicker the planting is started the better. There is little or no economic risk involved. If fuelwood needs do not climb, as we have suggested, the fuelwood plantations will provide the raw material for pulpmill development in a few years. Nothing less than a long, sustained collapse of world markets will prevent well-managed plantations of well-chosen timber species from becoming very valuable.

APPENDIX A. PROJECTIONS OF TIMBER STAND AND TIMBER PRODUCT OUTPUT IN SOUTH VIETNAM UNDER TWO ASSUMPTIONS OF TIMBER MANAGEMENT AND UTILIZATION

The following calculations describe what would happen to the timber resource, timber yields, and timber industry values under different circumstances of timber cut, forest practice, and industrial development. In the absence of accurate information concerning most of the factors, it has been necessary to base the calculations on what appear to be reasonable assumptions. For this reason, the projections must be regarded only as a general appraisal of the opportunities and problems involved in forestry development in South Vietnam.

PRESENT SITUATION

Basic assumptions of area, stand volume, and present timber cut

Assumption 1

There are 6.4 million hectares of forested land in South Vietnam. This includes 3 million hectares of good to excellent hardwood stands:

	Million hectares
Good to excellent hardwood stands	3.0
Poor to fair hardwood stands	2.8
Pine stands	0.2
Mangrove	0.4
Total	6.4

Assumption 2

The gross area figures include many openings occupied by bamboo, shifting agriculture plots, brush, etc. We estimate the above estimates of good to excellent forested area should be reduced 10 percent for that reason, and the poor to fair stands 20 percent.

	Million hectares
Good to excellent hardwoods (3.0 x .9)	2.7
Other stands (3.4 x .8)	2.7
Net forested area	5.4

Assumption 3

It would be a mistake to assume that all of the present timbered area in South Vietnam is suitable and available for timber cutting. Early observers commented on Vietnam's land erosion problems and the silting of reservoirs resulting from disturbance of the forest. The danger still persists and the problem of environmental protection will need continuing

attention. If serious heed is to be given to this problem and if even a minor effort is to be made to set up national parks and wildlife refuges, at least 15 percent of the present forested area in South Vietnam should be eliminated from timber production. This is probably a conservative estimate of the area best left uncut or only very lightly cut to hold the land in place or to fill recreation, esthetic, and wildlife purposes.

	Million hectares
Good to excellent hardwood stands (2.7 x .85)	2.3
Other stands (2.7 x .85)	2.3
Net forested area suitable for industrial production	4.6

Emphasis on esthetics in South Vietnam may seem out of place when the overriding issue is developing the basis for economic growth. However, once there is real peace in the country-side, tourism should become an important source of income. This provides a direct economic rationale as well as an environmental one for excluding some areas from intensive timber utilization.

Assumption 4

The average volume per hectare in the forested area classified as "good to excellent" has been estimated to be about 100 cubic meters. In the rest of the forested area the average volume is estimated to be 35 cubic meters per hectare. Both figures include trees 10 centimeters in diameter and larger.

	Million cubic meters
2.3 million hectares x 100 cubic meters	230
2.3 million hectares x 35 cubic meters	80
Total timber volume on area suitable for industrial production	310

Timber inventory data from Cambodia suggest that probably 35 percent of the total volume is in merchantable size trees--50 centimeters in diameter and larger.

310 x .35 = 110 million cubic meters

Assumption 5

We have assumed that the timber cut for industrial use will amount to 1.1 million cubic meters the first year, climbing to keep pace with population growth. In 1980 and subsequent years a per capita consumption of 0.12 cubic meters per year has been assumed.

	Million cubic meters
1974	1.1
1980	2.9
1990	3.8
2000	4.9

Assumption 6

All evidence indicates that, in the absence of supervision and pressure to do better, loggers are highly selective, taking the best trees of the most desirable species and at the same time leaving behind 20 to 30 percent of the measured volume in the trees actually cut. We have assumed, therefore, that the logs removed represent 75 percent of the volume of the trees actually felled. In this case the timber cut for industrial wood in the years mentioned would be:

	Million cubic meters 18/
1974	1.7
1980	4.1
1990	5.3
2000	6.7

Assumption 7

We have assumed also that provision will be made to fill fuelwood needs mainly from areas outside the industrial forest, and that the total drain on the industrial forest will not be increased by fuelwood cutting of trees 50 centimeters in diameter and larger.

Assumption 8

In 1925 the forested area in what is now South Vietnam was estimated to be about 7.8 million hectares. Since then it has been declining steadily, apparently at an average rate of about 30,000 hectares annually. With the continuation of present lack of management and control over activity in the forest, it seems safe to conclude that the process of deforestation and destruction of timber will increase with greater population pressure. We have assumed that the annual loss of timber would be equivalent to 80 percent of the volume of trees 50 centimeters in diameter and larger on 10,000 hectares of good to excellent forest land and 40,000 hectares of fair to poor forest. The other 20 percent of the volume would be salvaged.

	Cubic meters
10,000 hectares x 35 cubic meters x .8 =	280,000
40,000 hectares x 12 cubic meters x .8 =	384,000
	664,000

18/ Estimate includes 200,000 cubic meters for export.

Assumption 9

A crucial consideration is the assumed rate of current annual growth. Some of the virgin forest is in a static condition now, in that the trees are growing slowly and what growth is occurring is being offset by losses of various sorts. Cutting will stimulate growth. Some of the stimulation will be to the growth of brush, vines, and undesirable trees. Where desirable reproduction is naturally established, the growth will be in usable volume. However, this growth will not be added to the merchantable volume in the period considered in these calculations. Some larger trees will be "released" by the cutting--that is, be given more room to grow. This growth, which will add to the merchantable volume in the period being considered, is estimated at .25 cubic meter per hectare per year during the period 1980-89, and .5 cubic meter per hectare per year from 1990 to 1999.

PROJECTIONS UNDER PRESENT MANAGEMENT AND UTILIZATION

Appendix tables 1 and 2 show calculations of long-term timber volume trends in South Vietnam, assuming continuation of current forest management and protection and the present degree of industrial integration and utilization.

Appendix table 1.--Trends of total merchantable volume in industrial forest

Year	Forested area	Drain in previous period			Growth previous period	Volume as of Jan. 1 trees 50 cm+
		Cut for products	Destroyed volume	Total		
	Million hectares	Million cubic meters				
1974	4.6	---	---	---	---	110
1980	4.3	17.4	4.0	21.4	---	88.6
1990	3.8	47.0	6.6	53.6	10.1	45.1
2000	3.3	60.0	6.6	66.6	17.8	-3.7
	(Assumption 8)1/	(Assumption 6)	(Assumption 8)		(Assumption 9)	

1/ Assumption notations refer to the basic assumptions outlined at the beginning of Appendix A.

Timber cutting in South Vietnam has been characterized by heavy concentration on preferred species. The list of preferred species has been growing and we may expect that it will grow still more under the pressure of shortages. However, if the tendancy to be highly selective

persists, the more valuable species will be virtually exhausted much more rapidly than the total stand. For the purpose of the following calculation, it has been assumed that 80 percent of the timber cut is concentrated on species making up 55 percent of the volume.

Appendix table 2.--Trends of merchantable volume in industrial forest when cut of preferred species is emphasized

Year	Forested area	Drain in previous period			Growth previous period	Volume as of Jan. 1
		Cut for products	Destroyed volume	Total		
	Million hectares	Million cubic meters				
1974	4.6	---	---	---	---	60.5
1980	4.3	13.9	2.2	16.1	---	44.4
1990	3.8	37.6	3.6	41.2	5.6	8.8
2000	3.3	48.0	3.6	51.6	9.8	-33.0

LONG-TERM VOLUME TRENDS WITH IMPROVED MANAGEMENT

Assumptions

Assumption 1

About 75 percent of the industrial forested area will be clear cut (3,450,000 hectares), and 25 percent selectively cut (1,150,000 hectares).

Assumption 2

The forest will be cut on a 50-year rotation, which is a compromise between the rates of faster growing and slower growing species.

Assumption 3

On the clear-cut areas, all trees 20 centimeters and larger will be removed. In the selectively-cut areas, cutting will be confined to trees 50 centimeters plus.

Appendix table 3.--Tree size composition of South Vietnam forests

	Total volume	Volume per hectare	Percent
	Million cubic meters	------------Cubic meters------------	
Trees 50 cm+	110	23	35
Trees 20 cm+	230	50	75
Trees 10 cm+	310	67	100

Assumption 4

The annual cut will be:

69,000 hectares clear cut (3,450,000 hectares ÷ 50 years)
23,000 hectares selectively cut (1,150,000 hectares ÷ 50 years)
92,000 hectares total cut

Assumption 5

The volume cut annually from existing stands will be:

3,450,000 cubic meters clear cut (69,000 hectares x 50 cm per hectares)
529,000 cubic meters selectively cut (23,000 hectares x 23 cm per hectares)
3,979,000 cubic meters total cut

Assumption 6

All areas clear cut will be replanted and 1 million hectares not now forested will be planted over a 20-year period. One-third of the area will be planted to very fast-growing structural timber species on a 30-year rotation; two-thirds will be planted to slow-growing species, like teak, on a 60-year rotation.

	Hectares per year
Planting of clear cuts	69,000
Planting of present deforested areas	50,000
	119,000
Planting to fast-growing species	40,000
Planting to slow-growing species	79,000
	119,000

Assumption 7

There will be three commercial thinnings in all planted stands. To avoid the possibility of overstating the opportunities, the intermediate yields have been substantially discounted. The per hectare yields in appendix table 4 are only one-third as large as typical yield expectations presented in the text of this report. Furthermore, to allow for the possibility of time lag in the development of stands (for example, it might prove desirable to delay the final harvest of some stands beyond the planned rotation age), the yield expectations for the years 1994 and 2004 have been further discounted.

In the final analysis, this report if a prospectus. A common failing of prospectuses is overoptimism. Since we are analyzing here a situation and opportunity of profound significance to the fate of a nation, a deliberate effort has been made to be conservative in our calculations. This permits us to say with some confidence, therefore, that the yields and values projected are most reasonable. Moreover, in the longer-run, the yields and values can be far greater than those presented here.

Appendix table 4.--Assumed yields from planted stands

	Fast-growing structural species			Slow-growing species		
	Age years	Cubic meters per hectare	Percent of final cut	Age years	Cubic meters per hectare	Percent of final cut
1st commercial thinning	5	1	1	10	8	5
2nd " "	10	6	6	20	32	20
3rd " "	20	24	24	30	41	26
Final cut	30	101	100	60	159	100
Total		132			240	

Appendix table 5.--Total timber yield, representive years, cubic meters

Year	Yields			
	From existing stands	From plantations	Total	Discounted total yields
	Million cubic meters			
1974	4.0	---	4.0	4.0
1979	4.0	---	4.0	4.0
1984	4.0	0.9	4.9	4.9
1994	4.0	4.4	8.4	7.5
2004	4.0	11.6	15.6	11.0

APPENDIX B. PROJECTED VALUE OF TIMBER PRODUCT OUTPUT IN SOUTH VIETNAM

Projected timber yields in representative years, as interpolated from Appendix A, would be:

	Million cubic meters
1974	4.0
1980	4.3
1990	6.4
2000	9.8

Projected uses of this timber and associated values are shown in Appendix tables 6 and 7.

Appendix table 6.--Projected volume (log scale basis) and value of Vietnam's timber output with improved forestry and utilization

	Logs for export		Lumber		Plywood		Total
	Volume	Unit value	Volume	Unit value	Volume	Unit value	Volume
	Million m^3	Dollars	Million m^3	Dollars	Million m^3	Dollars	Million m^3
1974	.5	54	2.5	68	1.0	96	4.0
1980			3.0	73	1.3	105	4.3
1990			4.5	88	1.9	135	6.4
2000			6.9	103	2.9	145	9.8

Appendix table 7.--Projected total value of Vietnam's forest products

	Logs	Lumber	Plywood	Total
	---Million dollars---			
1974	27	170	96	293
1980		219	136	355
1990		396	257	653
2000		711	421	1,132

APPENDIX C. SPECIES OF TREES IN SOUTH VIETNAM AND THEIR USES

As in most tropical forests, the flora of South Vietnam includes a wide variety of trees; at least 60 families and 156 genera have been identified. Many are small, poor in shape, or limited in occurrence and, therefore, are not industrially important. Eliminating these, there are still several hundred species available for industrial use.

South Vietnam has both lightweight and heavy woods, but most of the species are fairly heavy. Some, in fact, are very heavy. Following, for comparison with the specific gravities in the species listings are the specific gravities of common United States hardwoods of the same moisture content (15 percent):

Basswood	.42
Yellow poplar	.49
Cherry	.58
Gum	.59
Black walnut	.62
Hard maple	.69
Yellow birch	.71
White oak	.76

Although the variety gives the timber a broad utility (i.e., there is a tree for every purpose for which wood can be used) the great number of species has, in the main, been a handicap. Individual loggers generally have limited requirements as to timber characteristics, thus tending to concentrate on only a few species.

Appendix C lists South Vietnam's tree species three ways. The first section lists them by:

1. Botanical families and genera native to South Vietnam.

2. Tree species native to South Vietnam, arranged alphabetically by botanical genera and species.

3. Tree species native to South Vietnam, arranged alphabetically by Vietnamese common name.

The second section presents the Directorate of Waters and Forests classification of these trees, and the third section lists the species by their suitability to various uses.

BOTANICAL FAMILIES AND GENERA NATIVE TO SOUTH VIETNAM

ANACARDIACEAE
- Mangifera
- Melanorrhea
- Polyalthia
- Spondias

ANNONACEAE
- Alphonsea
- Xylopia

APOCYNACEAE
- Alstonia
- Wrightia

AVICENNIACEAE
- Avicennia

BIGNONIACEAE
- Dolichandrone
- Markhamia
- Stereospermum

BOMBACACEAE
- Bombax
- Eriodendron

BUSERACEAE
- Canarium
- Garuga

CAPPARIDACEAE
- Capparis

CASUARINEACEAE
- Casuarina

CELASTRACEAE
- Lophopetalum

COMBRETACEAE
- Anogeissus
- Combretum
- Lumnitzera
- Terminalia

CRYPTERONIACEAE
- Crypteronia

CUPRESSACEAE
- Fokienia

DATISCACEAE
- Tetrameles

DILLENIACEAE
- Dillenia

DIPTEROCARPACEAE
- Anisoptera
- Dipterocarpus
- Hopea
- Parashorea
- Pentacme
- Shorea
- Vatica

EBONACEAE
- Diospyros

ELAEOCARPACEAE
- Elaeocarpus

EUPHORBIACEAE
- Bischofia
- Endospermum
- Erismanthus
- Exoecaria
- Gelonium
- Hevea
- Mallotus
- Sapium

FAGACEAE
- Castanopsis
- Pasania
- Quercus

FLACOURTIACEAE
- Homalium

GONYSTYLACEAE
- Gonystylus

GUTTIFERAE
- Calophyllum
- Cratoxylon
- Garcinia
- Mesua

HAMAMELIDACEAE
- Liquidambar

ICACINACEAE
- Apodytes

IXONANTHACEAE
- Ixonanthes

JUGLANDACEAE
- Engelhardtia
- Pterocaryia

LAURACEAE
- Cinnamomum
- Cyanodaphne
- Laurus
- Litsea
- Machilus

LECYTHIDACEAE
- Barringtonia
- Careya

LEGUMINOSAE
- Acacia
- Afzelia
- Albizia
- Bauhinia
- Caesalpinia
- Cassia
- Dalbergia
- Dialium
- Erythrina
- Erythrophloeum
- Intsia
- Lysidice
- Parkia
- Peltophorum
- Pterocarpus
- Samanea
- Sindora
- Spatholobus
- Tamarindus
- Xylia

LOGANIACEAE
- Fagraea

LYTRACEAE
- Lagerstroemia

MAGNOLIACEAE
- Manglietia
- Michelia
- Talauma

MELASTOMACEAE
- Memecylon

MELIACEAE
- Aglaia
- Carapa
- Chukrassia
- Dysoxylum
- Khaya
- Melia
- Sandoricum
- Swietenia
- Toona

MORACEAE
- Antiaris
- Artocarpus
- Ficus
- Morus

MYRCINACEAE
- Aegiceras

MYRISTICACEAE
- Knema

MYRTACEAE
- Eucalyptus
- Eugenia
- Melaleuca

OLEACEAE
- Osmanthus

PINACEAE
- Keteleeria
- Pinus

PODOCARPACEAE
- Dacrydium
- Podocarpus

POLYGALACEAE
- Xanthophyllum

RHIZOPHORACEAE
- Bruguiera
- Carallia
- Ceriops
- Kandelia
- Rhizophora

ROSACEAE
- Parinari
- Pygeum

RUBIACEAE
- Adina
- Anthocephalus
- Canthium
- Morinda
- Sarcocephalus

RUTACEAE
- Acronychia
- Aegle
- Glycosmis

SAPINDACEAE
- Euphoria
- Nephelium
- Pometia
- Sapindas
- Xerospermum

SAPOTACEAE
- Bassia
- Payena
- Sideroxylon

SIMAROUBACEAE
- Irvingia

FLACOURTIACEAE
- Hydnocarpus

SONNERATIACEAE
- Duabanga
- Sonneratia

STERCULIACEAE
- Pterospermum
- Sterculia
- Tarrietia

STRYACACEAE
- Styrax

SYMPLOCACEAE
- Symplocos

TAXODIACEAE
- Cunninghamia

THEACEAE
- Schima

TILIACEAE
- Brownlowia
- Pentace

ULMACEAE
- Gironniera
- Holoptelea

VERBENACEAE
- Gmelina
- Tectona
- Vitex

SPECIES NATIVE TO SOUTH VIETNAM - ARRANGED ALPHABETICALLY BY BOTANICAL GENERA AND SPECIES

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY*
	Bay Thuc	
	Ca Vat	
	Da Gui	
	Dien Dien	
	Do Ngon	
	Dong	
	Dua Cao	
	Dut	
	En	
	Gang	
	Giai Nai	
	La Hop	
	Lan Tan	
	Leo Heo	
	Luong Tuong	
	Mong Tay	
	Mung	
	No	
	Phao	
	Lai	
	Sang Hop	
	So Dua	
	Ta Hoang	
	Thoai	
	Thoi Chanh	
	Tim Lang	
	Vay Oc	
	Vo Va	
	Voi	
	Vong	
Acacia farnesiana	Keo	
Acronychia laurifolia	Bi Bai	
Adina cordifolia	Gao Dang De	1.32
Adina cordifolia	Gao Vang	1.32
Adina polycephala	Dang De	
Aegiceras majus	Tru	
Aegle marmelos	Bau Bau	
Afzelia cochinchinensis	Ca Te	.83
Afzelia cochinchinensis	Go Do	.83
Afzelia cochinchinensis	Go To Te	.83
Afzelia cochinchinensis	Ho Bi	.83
Aglaia gigantea	Goi	.72

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Albizia lebbekoides	Sua	
Albizia lucida	Ban Xe	.63
Albizia stipulata	Chua	.40
Alphonsea spp.	Chai	
Alstonia scholaris	Mo Cua	.44
Alstonia scholaris	Sua	.44
Alstonia spathulata	Mo Cua	.46
Alstonia spathulata	Mop	.46
Anisoptera cochinchinensis	Ven Ven	
Anisoptera glabra	Ven Ven	
Anisoptera oblonga	Ven Ven	
Anisoptera scaphula	Ven Ven	
Anisoptera spp.	Ven Ven	.66
Anogeissus vulgaris	Ram	
Anthocephalus cadamba	Gao	
Anthocephalus indices	Gao Trang	
Antiaris toxicaria	Sui	
Apodytes giung	Chim Chim	
Artocarpus asperula	Mit Nai	
Artocarpus hirsuta	Mit Nai	
Artocarpus integrifolia	Mit	.67
Artocarpus integrifolia	Mit Nai	.67
Artocarpus tonkinensis	Chay	.59
Avicennia intermedia	Mam Trang	
Avicennia marina	Mam Den	
Avicennia officinalis	Mam	
Barringtonia acutangula	Rau Chiet	
Barringtonia spp.	Rau Vung	
Bassia pasquieri	San	.95
Bassia pasquieri	Sen	.95
Bauhinia variegata	Bang	
Bauhinia variegata	Mong Bo	
Bischofia javanica	Nhoi	.78
Bombax anceps	Gao	
Bombax malabaricum	Gao Tia	.33
Bombax malabaricum	Gao	.33

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Brownlowia densysiana	Lo Bo	
Brownlowia densysiana	So Do	
Bruguiera caryophylloides	Vet Du	
Bruguiera eriopetala	Vet	
Bruguiera gymnorhiza	Vet	.62
Bruguiera parviflora	Vet Tach	
Caesalpinia pulcherrina	Diep	
Calophyllum divers	Cong	
Calophyllum inophyllum	Mu U	
Calophyllum saigonensis	Cong	.65
Canarium album	Ca Na	.60
Canarium copaliferum	Cham Trang	.69
Canarium nigrum	Ca Na	.55
Canarium nigrum	Cham	.55
Canarium nigrum	Tram Hoag	.55
Canthium didymum	Xuong Ca	
Capparis grandis	Bung Bi	
Carallia lucida	Sang Ma	
Carallia lucida	Tia	
Carallia spp.	Sang Vi	
Carapa obovata	Su	
Carapa obovata	Vung	
Careya arborea	Vung	
Cassia siamea	Muong	1.12
Cassia siamea	Muong Den	1.12
Cassia timoriensis	Do	
Cassia timoriensis	Muong Tia	
Cassia timoriensis	Tia	
Cassia tonkinensis	Muong Trang	.61
Castanopsis indica	Ca Oi	
Castanopsis tribuloides	Ca Oi	.73
Casuarina equisetifolia	Duong Lieu	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Ceriops candolleana	Da	
Ceriops candolleana	Da Quang	
Ceriops roxburghiana	Da Oanh	
Ceriops roxburghiana	Da Voi	
Chukrassia	Nao	
Chukrassia tabularis	Chua Khet	.82
Chukrassia tabularis	Lat Hoa	.82
Cinnamomum camphora	Long Nao	.80
Cinnamomum camphora	Re Huong	.80
Cinnamomum divers	Re	
Cinnamomum illiciodes	Go Huong	
Cinnamomum iners	Hau Phai	
Cinnamomum obtusifolium	Re Huong	
Cinnamomum spp.	Huong	.64
Cinnamomum spp.	Re	.64
Cinnamomum zeylanicum	O Duoc	.50
Combretum quadrangulare	Chung Bau	
Cratoxylon formosum	Lanh Nganh	.75
Cratoxylon polyanthum	Oi Rung	
Crypteronia paniculata	Loi	
Cunninghamia sinensis	Samou	.45
Cyanodaphne cuneata	Ca Duoi	1.05
Dacrydium elatum	Hoang Dan	
Dalbergia bariensis	Cam Lai	.99
Dalbergia cochinchinensis	Trac	1.05
Dalbergia nigrescens	Quach	
Dialium cochinchinensis	Xoay	1.15
Dillenia aurea	So	
Dillenia elata	So	
Diospyros lucida	Sang Den	
Diospyros mun	Mun	1.30
Diospyros rubra	Thi	
Diospyros siamensis	Cam Thi	.84

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Dipterocarpus	Dau Nuoc	
Dipterocarpus alatus	Dau Con Rai	
Dipterocarpus articarpifolius	Dau Mit	
Dipterocarpus dyerii	Dau Song Nan	
Dipterocarpus hasseltii	Dau Cac	
Dipterocarpus intricatus	Dau Long	
Dipterocarpus obtusifolius	Dau Tra Beng	
Dipterocarpus spp.	Dau Cac Loai	.80
Dipterocarpus tonkinensis	Cho Nau	.60
Dipterocarpus tuberculatus	Dau Dong	
Dipterocarpus tuberculatus	Dau Son	
Dolichandrone rheedii	Quao	
Duabanga sonneratioides	Phay	.38
Dysoxylum loureirii	Bach Duong	.79
Dysoxylum loureirii	Huynh Duong	.79
Elaeocarpus tomentosa	Chan Chan	
Endospermum sinensis	Vang Trang	
Engelhardtia chrysolepsis	Cheo	.58
Eriodendron anfractuosum	Gon	
Erismanthus indochinensis	Mop	
Erythrina indica	Ngo Dong	
Erythrophloeum fordii	Lim	.90
Erythrophloeum fordii	Lim Xanh	.90
Eucalyptus alba	Bac Ha	
Eucalyptus camalulensis	Bac Ha	
Eucalyptus citriodora	Bac Ha	
Eucalyptus globulis	Bac Ha	
Eucalyptus grandis	Bac Ha	
Eucalyptus obliqua	Bac Ha	
Eucalyptus punctata	Bac Ha	
Eucalyptus robusta	Bac Ha	
Eucalyptus rostrata	Bac Ha	
Eucalyptus saligna	Bac Ha	
Eucalyptus spp.	Bac Ha	
Eucalyptus tereticornis	Bac Ha	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Eugenia spp.	Cac Loai	.95
Eugenia spp.	Tram	.95
Eugenia tinctoria	Sang	
Euphoria longana	Nhan Rung	
Excoecaria agallocha	Gia	
Fagraea fagrans	Trai	
Ficus spp.	Gua	.32
Ficus spp.	Sung	.32
Fokienia hodginsii	Pe Mu	
Fokienia kawai	Pe Mu	.47
Garcinia fagraoides	Ly	1.01
Garcinia fagraoides	Trai	1.01
Garcinia ferrea	Roi	
Garcinia loureirii	Nua	
Garuga pinnata	Dau Heo	
Gelonium multiflorum	Ngong Tau	
Gironniera sinensis	Ngat	.51
Glycosmis citrifolia	Buoi Bung	.51
Gmelina arborea	Loi Tho	
Gonystylus cochinchinensis	Sang Su	
Hevea braziliensis	Cao Su	
Holoptelea integrifolia	Nong Heo	
Homalium dictyoneurum	Nhut	
Homalium meliosia	Song	
Hopea	Bo	
Hopea dealbata	Sao	.80
Hopea ferrea	Sang Dao	.86
Hopea odorata	Sao Den	.85
Hopea odorata	Sao Xanh	.85
Hopea pierreii	Kien Kien	.88

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Hydnocarpus anthelminthica	Chum Bao	
Intsia spp.	Gu Nuoc	
Irvingia oliveri	Cay	
Ixonanthes cochinchinensis	Nu	
Kandelia rheeddii	Vet Dia	
Keteleeria davidiana	Ngo Tung	.87
Khaya senegalensis	So Khi	
Knema conferta	Mau Cho	.62
Knema corticosa	Sang Mau	
Lagerstroemia divers	Bang Lang	.71
Lagerstroemia divers	Sang Le	.71
Lagerstroemia divers	Thao Lao	.71
Laurus camphorata	Chuong	
Liquidambar formosama	Cay Sau	
Liquidambar formosama	Thau	.77
Litsea longipes	Du	
Litsea spp.	Vu	
Litsea vang	Boi Loi	.67
Lophopetalum duperreanum	Ba Khia	.56
Lophopetalum duperreanum	Sang Trang	.56
Lophopetalum wrightianum	Ba Khia	
Lumnitzera coccinea	Coc	
Lysidice rhodostegia	My	.61
Machilus trijuga	Vang Ve	
Mallotus cochinchinensis	Vang	.40
Mallotus cochinchinensis	Vang Trung	.40
Mangifera forida	Xoai Queo	
Mangifera indica	Xoai Hoi	.67
Mangifera spp.	Xoai Rung	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Manglietia glauca	Mo Vang Tam	.41
Manglietia glauca	Vang Tam	.41
Markhamia stipulata	Dinh	.67
Melaleuca leucadendron	Tram	.75
Melanorrhea laccifera	Son	.89
Melia azaderach	Sau Dau	.53
Melia azaderach	Xoan	.53
Melia divers	Xoan	
Memecylon spp.	Sam	
Mesua ferrea	Vap	1.11
Michelia bariensis	Gioi	
Michelia mediocris	Gioi	
Morinda tinctoria	Nhau	
Morus indica	Dau	
Morus nigra	Glau	.60
Nephelium litchi	Vai Trac	.37
Osmanthus fagrans	Hue Moc	
Parashorea densiflora	Cho Chi	
Parashorea lucida	Cho Chi	
Parashorea spp.	Cho Chi	
Parashorea stellata	Cac Loai	.82
Parashorea stellata	Cho	.82
Parinari annamensis	Cam	.76
Parkia dongnaiensis	Thui	
Pasania fissa	Bop	.48
Pasania fissa	Soi Bop	.48

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Pasania spp.	Bop	.68
Pasania spp.	Gie	.68
Pasania spp.	Lim	.68
Pasania spp.	Soi	.68
Payena elliptica	Vet	.81
Payena elliptica	Viet	.81
Peltophorum dasyrachi	Hoang Lim	.90
Peltophorum dasyrachi	Lim Xet	.90
Peltophorum ferrugineum	Lim Xet	.90
Peltophorum tonkinensis	Hoang Hah	.76
Pentacme siamensis	Ca Chac Xanh	
Pentacme tonkinensis	Nghien	1.10
Pinus armandii	Thong	
Pinus caribaea	Thong	
Pinus dalatensis	Thong	
Pinus elliottii	Thong	
Pinus excelsea	Thong	
Pinus griffithii	Thong	
Pinus kesiya	Ngo Mu 3La	.65
Pinus kesiya	Thong Ba La	.65
Pinus kesiya	Thong Mu 3La	.65
Pinus krempfii	Thong	
Pinus massoniana	Thong	
Pinus merkusii	Ngo Mu 2La	.70
Pinus merkusii	Thong Hai La	.70
Pinus merkusii	Thong Mu 2La	.70
Pinus patula	Thong	
Podocarpus cupressina	Thong Tre	
Podocarpus fleuryi	Thong	
Podocarpus imbricatus	Bach Tung	.46
Podocarpus latifolia	Kim Giao	
Podocarpus neriifolius	Thong	
Polyalthia jucunda	Ten	
Polyalthia spp.	Ngan Chay	
Pometia pinnata	Truong	.90
Pterocarpus	Loai Thu	
Pterocarpus pedatus	Dang Huong	.84
Pterocarpus pedatus	May Douk	.84

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Pterocaryia spp.	Du	
Pterocaryia stenoptera	Coi	
Pterospermum diversifolium	Long Mang	
Pterospermum diversifolium	Mang	
Pterospermum grewiaefolium	Mang Mang	.46
Pterospermum spp.	Long Mang	
Pterospermum spp.	Mang	
Pterospermum truncatolobatum	Long Mang	
Pygeum arboreum	Dao	.50
Pygeum arboreum	Xoan Dao	.50
Quercus spp.	Bop	.68
Quercus spp.	Gie	.68
Quercus spp.	Lim	.68
Quercus spp.	Soi	.68
Rhizophora conjugata	Duoc Xanh	1.05
Rhizophora mucronata	Dang	1.05
Rhizophora racemosa	Duoc	
Samanea saman	Me Tay	
Sandoricum indicum	Sau Do	.55
Sandoricum indicum	Sau Trang	.55
Sapindas mukorossi	Su	
Sapindas mukorossi	Xu	
Sapium sebiferum	Soi	.55
Sarcocephalus cordatus	Cay Gao	.56
Schima spp.	Cho Xot	
Shorea cochinchinensis	Sen Mu	.88
Shorea hypochra	Lumbor	.82
Shorea hypochra	Sen Bo Bo	.82
Shorea obtusa	Ca Chac	1.10
Shorea obtusa	Ca Chi	1.10
Shorea spp.	Bo Bo	
Shorea talura	Sen Mu	
Shorea vulgaris	Chai	.87
Sideroxylon eburneum	Choi	
Sideroxylon eburneum	May Lai	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Sindora cochinchinensis	Go Bong Lau	1.00
Sindora cochinchinensis	Go Mat	1.00
Sindora tonkinensis	Gu	
Sonneratia acida	Bau	
Sonneratia acida	Cac Ban	
Spatholobus orientalis	Rang Rang	.54
Spondias lutea	Coc Gao	
Spondias mangifera	Coc Chua	
Spondias tonkinensis	Noan Dai	.37
Sterculia lychnophora	Trom	
Sterculia lychnophora	Vang	
Sterculia lychnophora	Voi	
Sterculia pexa	Trom	
Sterculia pexa	Vang	
Sterculia pexa	Voi	
Sterculia spp.	Trom	
Sterculia spp.	Vang	
Sterculia spp.	Voi	
Stereospermum annamensis	Ke	.90
Stereospermum annamensis	Khe	.90
Styrax benzoin	Bo De	
Styrax tonkinensis	Bo De	.41
Swietenia macrophylla	Giai Ngua	
Symplocos laurina	Dung	
Talauma gioi	Dau Gio	.60
Talauma gioi	Gioi	.60
Tamarindus indica	Me	
Tarrietia cochinchinensis	Huynh	.74
Tarrietia littoralis	Cui	
Tectona grandis	Gia Ty	.65
Tectona grandis	Teck	.65
Terminalia catappa	Bang	
Terminalia catappa	Chieu Lieu	
Terminalia chebula	Chieu Lieu	.87

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Terminalia ivorensis	Chieu Lieu	
Terminalia spp.	Chieu Lieu	.85
Terminalia tomentosa	Bang Lang Khe	
Terminalia tomentosa	Ca Gan	
Terminalia tomentosa	Cam Lien	
Tetrameles nudiflora	Tung	.40
Toona febrifuga	May Num	.54
Toona febrifuga	Xoan Moc	.55
Toona febrifuga	Xuong Mot	.55
Vatica dyerii	Lau Tau	.97
Vatica tonkinensis	Tau	.89
Vatica tonkinensis	Tau Mat	.89
Vitex pubescens	Binh Linh	1.00
Vitex sumatrana	Hap	
Wrightia annamensis	Long Muc	.43
Xanthophyllum cochinchinensis	Sang Da	.87
Xanthophyllum colybrinum	Sang Da	
Xanthophyllum excelsum	Thach Luc	
Xerospermum macrophyllum	Truong	.90
Xylia dolabriformis	Cam Xe	1.15
Xylia kerrii	Da Da	.96
Xylopia pierreii	Den	

* Specific gravity determined at 15 percent moisture content.

SPECIES NATIVE TO SOUTH VIETNAM - ARRANGED ALPHABETICALLY BY VIETNAMESE COMMON NAME

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY*
Lophopetalum duperreanum	Ba Khia	.56
Lophopetalum wrightianum	Ba Khia	
Eucalyptus alba	Bac Ha	
Eucalyptus camalulensis	Bac Ha	
Eucalyptus citriodora	Bac Ha	
Eucalyptus globulis	Bac Ha	
Eucalyptus grandis	Bac Ha	
Eucalyptus obliqua	Bac Ha	
Eucalyptus punctata	Bac Ha	
Eucalyptus robusta	Bac Ha	
Eucalyptus rostrata	Bac Ha	
Eucalyptus saligna	Bac Ha	
Eucalyptus spp.	Bac Ha	
Eucalyptus tereticornis	Bac Ha	
Dysoxylum loureirii	Bach Duong	.79
Podocarpus imbricatus	Bach Tung	.46
Albizia lucida	Ban Xe	.63
Bauhinia variegata	Bang	
Terminalia catappa	Bang	
Lagerstroemia divers	Bang Lang	.71
Terminalia tomentosa	Bang Lang Khe	
Sonneratia acida	Bau	
Aegle marmelos	Bau Bau	
	Bay Thuc	
Acronychia laurifolia	Bi Bai	
Vitex pubescens	Binh Linh	1.00
Hopea	Bo	
Shorea spp.	Bo Bo	
Styrax benzoin	Bo De	
Styrax tonkinensis	Bo De	.41
Litsea vang	Boi Loi	.67
Pasania fissa	Bop	.48
Pasania spp.	Bop	.68
Quercus spp.	Bop	.68
Capparis grandis	Bung Bi	
Glycosmis citrifolia	Buoi Bung	.51
Shorea obtusa	Ca Chac	1.10
Pentacme siamensis	Ca Chac Xanh	
Shorea obtusa	Ca Chi	1.10
Cyanodaphne cuneata	Ca Duoi	1.05
Terminalia tomentosa	Ca Gan	
Canarium album	Ca Na	.60
Canarium nigrum	Ca Na	.55
Castanopsis indica	Ca Oi	
Castanopsis tribuloides	Ca Oi	.73
Afzelia cochinchinensis	Ca Te	.83

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
	Ca Vat	
Sonneratia acida	Cac Ban	
Eugenia spp.	Cac Loai	.95
Parashorea stellata	Cac Loai	.82
Parinari annamensis	Cam	.76
Dalbergia bariensis	Cam Lai	.99
Terminalia tomentosa	Cam Lien	
Diospyros siamensis	Cam Thi	.84
Xylia dolabriformis	Cam Xe	1.15
Hevea braziliensis	Cao Su	
Irvingia oliveri	Cay	
Sarcocephalus cordatus	Cay Gao	.56
Liquidambar formosama	Cay Sau	
Alphonsea spp.	Chai	
Shorea vulgaris	Chai	.87
Canarium nigrum	Cham	.55
Canarium copaliferum	Cham Trang	.69
Elaeocarpus tomentosa	Chan Chan	
Artocarpus tonkinensis	Chay	.59
Engelhardtia chrysolepsis	Cheo	.58
Terminalia catappa	Chieu Lieu	
Terminalia chebula	Chieu Lieu	.87
Terminalia ivorensis	Chieu Lieu	
Terminalia spp.	Chieu Lieu	.85
Apodytes giung	Chim Chim	
Parashorea stellata	Cho	.82
Parashorea densiflora	Cho Chi	
Parashorea lucida	Cho Chi	
Parashorea spp.	Cho Chi	
Dipterocarpus tonkinensis	Cho Nau	.60
Schima spp.	Cho Xot	
Sideroxylon eburneum	Choi	
Albizia stipulata	Chua	.40
Chukrassia tabularis	Chua Khet	.82
Hydnocarpus anthelminthica	Chum Bao	
Combretum quadrangulare	Chung Bau	
Laurus camphorata	Chuong	
Lumnitzera coccinea	Coc	
Spondias mangifera	Coc Chua	
Spondias lutea	Coc Gao	
Pterocaryia stenoptera	Coi	
Calophyllum divers	Cong	
Calophyllum saigonensis	Cong	.65
Tarrietia littoralis	Cui	
Ceriops candolleana	Da	
Xylia kerrii	Da Da	.96

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
	Da Gui	
Ceriops roxburghiana	Da Oanh	
Ceriops candolleana	Da Quang	
Ceriops roxburghiana	Da Voi	
Rhizophora mucronata	Dang	1.05
Adina polycephala	Dang De	
Peterocarpus pedatus	Dang Huong	.84
Pygeum arboreum	Dao	.50
Morus indica	Dau	
Dipterocarpus hasseltii	Dau Cac	
Dipterocarpus spp.	Dau Cac Loai	.80
Dipterocarpus alatus	Dau Con Rai	
Dipterocarpus tuberculatus	Dau Dong	
Talauma gioi	Dau Gio	.60
Garuga pinnata	Dau Heo	
Dipterocarpus intricatus	Dau Long	
Dipterocarpus articarpifolius	Dau Mit	
Dipterocarpus	Dau Nuoc	
Dipterocarpus tuberculatus	Dau Son	
Dipterocarpus dyerii	Dau Song Nan	
Dipterocarpus obtusifolius	Dau Tra Beng	
Xylopia pierreii	Den	
	Dien Dien	
Caesalpinia pulcherrina	Diep	
Markhamia stipulata	Dinh	.67
Cassia timoriensis	Do	
	Do Ngon	
	Dong	
Litsea longipes	Du	
Pterocaryia spp.	Du	
	Dua Cao	
Symplocos laurina	Dung	
Rhizophora racemosa	Duoc	
Rhizophora conjugata	Duoc Xanh	1.05
Casuarina equisetifolia	Duong Lieu	
	Dut	
	En	
	Gang	
Anthocephalus cadamba	Cao	
Adina cordifolia	Gao Dang De	1.32
Bombax malabaricum	Gao Tia	.33
Anthocephalus indices	Gao Trang	
Adina cordifolia	Gao Vang	1.32
Excoecaria agallocha	Gia	
Tectona grandis	Gia Ty	.65

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
	Giai Nai	
Swietenia macrophylla	Giai Ngua	
Pasania spp.	Gie	.68
Quercus spp.	Gie	.68
Michelia bariensis	Gioi	
Michelia mediocris	Gioi	
Talauma gioi	Gioi	.60
Morus nigra	Glau	.60
Sindora cochinchinensis	Go Bong Lau	1.00
Afzelia cochinchinensis	Go Do	.83
Cinnamomum illiciodes	Go Huong	
Sindora cochinchinensis	Go Mat	1.00
Afzelia cochinchinensis	Go To Te	.83
Bombax anceps	Goa	
Bombax malabaricum	Goa	.33
Aglaia gigantea	Goi	.72
Eriodendron anfractudsum	Gon	
Sindora tonkinensis	Gu	
Intsia spp.	Gu Nuoc	
Ficus spp.	Gua	.32
Vitex sumatrana	Hap	
Cinnamomum iners	Hau Phai	
Afzelia cochinchinensis	Ho Bi	.83
Dacrydium elatum	Hoang Dan	
Peltophorum tonkinensis	Hoang Hah	.76
Peltophorum dasyrachi	Hoang Lim	.90
Osmanthus fagrans	Hue Moc	
Cinnamomum spp.	Huong	.64
Tarrietia cochinchinensis	Huynh	.74
Dysoxylum loureirii	Huynh Duong	.79
Stereospermum annamensis	Ke	.90
Acacia farnesiana	Keo	
Stereospermum annamensis	Khe	.90
Hopea pierreii	Kien Kien	.88
Podocarpus latifolia	Kim Giao	
	La Hop	
	Lan Tan	
Cratoxylon formosum	Lanh Nganh	.75
Chukrassia tabularis	Lat Hoa	.82
Vatica dyerii	Lau Tau	.97
	Leo Heo	
Erythrophloeum fordii	Lim	.90
Pasania spp.	Lim	.68

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Quercus spp.	Lim	.68
Erythrophloeum fordii	Lim Xanh	.90
Peltophorum dasyrachi	Lim Xet	.90
Peltophorum ferrugineum	Lim Xet	.90
Brownlowia densysiana	Lo Bo	
Pterocarpus	Loai Thu	
Crypteronia paniculata	Loi	
Gmelina arborea	Loi Tho	
Pterospermum diversifolium	Long Mang	
Pterospermum spp.	Long Mang	
Pterospermum truncatolobatum	Long Mang	
Wrightia annamensis	Long Muc	.43
Cinnamomum camphora	Long Nao	.80
Shorea hypochra	Lumbor	.82
	Luong Tuong	
Garcinia fagraoides	Ly	1.01
Avicennia officinalis	Mam	
Avicennia marina	Mam Den	
Avicennia intermedia	Mam Trang	
Pterospermum diversifolium	Mang	
Pterospermum spp.	Mang	
Pterospermum grewiaefolium	Mang Mang	.46
Knema conferta	Mau Cho	.62
Pterocarpus pedatus	May Douk	.84
Sideroxylon eburneum	May Lai	
Toona febrifuga	May Num	.54
Tamarindus indica	Me	
Samanea saman	Me Tay	
Artocarpus integrifolia	Mit	.67
Artocarpus asperula	Mit Nai	
Artocarpus hirsuta	Mit Nai	
Artocarpus integrifolia	Mit Nai	.67
Alstonia scholaris	Mo Cua	.44
Alstonia spathulata	Mo Cua	.46
Manglietia glauca	Mo Vang Tam	.41
Bauhinia variegata	Mong Bo	
	Mong Tay	
Alstonia spathulata	Mop	.46
Erismanthus indochinensis	Hop	
Calophyllum inophyllum	Mu U	
Diospyros mun	Mun	1.30
	Mung	
Cassia siamea	Muong	1.12
Cassia siamea	Muong Den	1.12
Cassia timoriensis	Muong Tia	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Cassia tonkinensis	Muong Trang	.61
Lysidice rhodostegia	My	.61
Chukrassia	Nao	
Polyalthia spp.	Ngan Chay	
Gironniera sinensis	Ngat	.51
Pentacme tonkinensis	Nghien	1.10
Erythrina indica	Ngo Dong	
Pinus merkusii	Ngo Mu 2La	.70
Pinus kesiya	Ngo Mu 3La	.65
Keteleeria davidiana	Ngo Tung	.87
Gelonium multiflorum	Ngong Tau	
Euphoria longana	Nhan Rung	
Morinda tinctoria	Nhau	
Bischofia javanica	Nhoi	.78
Homalium dictyoneurum	Nhut	
	No	
Spondias tonkinensis	Noan Dai	.37
Holoptelea integrifolia	Nong Heo	
Ixonanthes cochinchinensis	Nu	
Garcinia loureirii	Nua	
Cinnamomum zeylanicum	O Duoc	.50
Cratoxylon polyanthum	Oi Rung	
Fokienia hodginsii	Pe Mu	
Fokienia kawai	Pe Mu	.47
	Phao Lai	
Duabanga sonneratioides	Phay	.38
Dalbergia nigrescens	Quach	
Dolichandrone rheedii	Quao	
Anogeissus vulgaris	Ram	
Spatholobus orientalis	Rang Rang	.54
Barringtonia acutangula	Rau Chiet	
Barringtonia spp.	Rau Vung	
Cinnamomum divers	Re	
Cinnamomum spp.	Re	.64
Cinnamomum camphora	Re Huong	.80
Cinnamomum obtusifolium	Re Huong	
Garcinia ferrea	Roi	
Memecylon spp.	Sam	
Cunninghamia sinensis	Samou	.45
Bassia pasquieri	San	.95

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Eugenia tinctoria	Sang	
Xanthophyllum cochinchinensis	Sang Da	.87
Xanthophyllum colybrinum	Sang Da	
Hopea ferrea	Sang Dao	.86
Diospyros lucida	Sang Den	
	Sang Hop	
Lagerstroemia divers	Sang Le	.71
Carallia lucida	Sang Ma	
Knema corticosa	Sang Mau	
Gonystylus cochinchinensis	Sang Su	
Lophopetalum duperreanum	Sang Trang	.56
Carallia spp.	Sang Vi	
Hopea dealbata	Sao	.80
Hopea odorata	Sao Den	.85
Hopea odorata	Sao Xanh	.85
Melia azaderach	Sau Dau	.53
Sandoricum indicum	Sau Do	.55
Sandoricum indicum	Sau Trang	.55
Bassia pasquieri	Sen	.95
Shorea hypochra	Sen Bo Bo	.82
Shorea cochinchinensis	Sen Mu	.88
Shorea talura	Sen Mu	
Dillenia aurea	So	
Dillenia elata	So	
Brownlowia densysiana	So Do	
	So Dua	
Khaya senegalensis	So Khi	
Pasania spp.	Soi	.68
Quercus spp.	Soi	.68
Sapium sebiferum	Soi	.55
Pasania fissa	Soi Bop	.48
Melanorrhea laccifera	Son	.89
Homalium meliosia	Song	
Carapa obovata	Su	
Sapindas mukorossi	Su	
Albizia lebbekoides	Sua	
Alstonia scholaris	Sua	.44
Antiaris toxicaria	Sui	
Ficus spp.	Sung	.32
	Ta Hoang	
Vatica tonkinensis	Tau	.89
Vatica tonkinensis	Tau Mat	.89
Tectona grandis	Teck	.65
Polyalthia jucunda	Ten	
Xanthophyllum excelsum	Thach Luc	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Lagerstroemia divers	Thao Lao	.71
Liquidambar formosama	Thau	.77
Diospyros rubra	Thi	
	Thoai	
	Thoi Chanh	
Pinus armandii	Thong	
Pinus caribaea	Thong	
Pinus dalatensis	Thong	
Pinus elliottii	Thong	
Pinus excelsea	Thong	
Pinus griffithii	Thong	
Pinus krempfii	Thong	
Pinus massoniana	Thong	
Pinus patula	Thong	
Podocarpus fleuryi	Thong	
Podocarpus neriifolius	Thong	
Pinus kesiya	Thong Ba La	.65
Pinus merkusii	Thong Hai La	.70
Pinus merkusii	Thong Mu 2La	.70
Pinus kesiya	Thong Mu 3La	.65
Podocarpus cupressina	Thong Tre	
Parkia dongnaiensis	Thui	
Carallia lucida	Tia	
Cassia timoriensis	Tia	
	Tim Lang	
Dalbergia cochinchinensis	Trac	1.05
Fagraea fagrans	Trai	
Garcinia fagraoides	Trai	1.01
Canarium nigrum	Tram Hoag	.55
Eugenia spp.	Tram	.95
Melaleuca leucadendron	Tram	.75
Sterculia lychnophora	Trom	
Sterculia pexa	Trom	
Sterculia spp.	Trom	
Aegiceras majus	Tru	
Pometia pinnata	Truong	.90
Xerospermum macrophyllum	Truong	.90
Tetrameles nudiflora	Tung	.40
Nephelium litchi	Vai Trac	.37
Mallotus cochinchinensis	Vang	.40
Sterculia lychnophora	Vang	
Sterculia pexa	Vang	
Sterculia spp.	Vang	
Manglietia glauca	Vang Tam	.41
Endospermum sinensis	Vang Trang	

SCIENTIFIC NAME	VIETNAMESE COMMON NAME	SPECIFIC GRAVITY
Mallotus cochinchinensis	Vang Trung	.40
Machilus trijuga	Vang Ve	
Mesua ferrea	Vap	1.11
	Vay Oc	
Anisoptera cochinchinensis	Ven Ven	
Anisoptera glabra	Ven Ven	
Anisoptera oblonga	Ven Ven	
Anisoptera scaphula	Ven Ven	
Anisoptera spp.	Ven Ven	.66
Bruguiera eriopetala	Vet	
Bruguiera gymnorhiza	Vet	.62
Payena elliptica	Vet	.81
Kandelia rheeddii	Vet Dia	
Bruguiera caryophylloides	Vet Du	
Bruguiera parviflora	Vet Tach	
Payena elliptica	Viet	.81
	Vo Va	
	Voi	
Sterculia lychnophora	Voi	
Sterculia pexa	Voi	
Sterculia spp.	Voi	
	Vong	
Litsea spp.	Vu	
Carapa obovata	Vung	
Careya arborea	Vung	
Mangifera indica	Xoai Hoi	.67
Mangifera forida	Xoai Queo	
Mangifera spp.	Xoai Rung	
Melia azaderach	Xoan	.53
Melia divers	Xoan	
Pygeum arboreum	Xoan Dao	.50
Toona febrifuga	Xoan Moc	.55
Dialium cochinchinensis	Xoay	1.15
Sapindas mukorossi	Xu	
Canthium didymum	Xuong Ca	
Toona febrifuga	Xuong Mot	.55

*Specific gravity determined at 15 percent moisture content.

DIRECTORATE OF WATERS AND FORESTS
CLASSIFICATION OF SOUTH VIETNAM TREES

The Directorate of Waters and Forests has classified the timber of South Vietnam into four general groups. The following classification was issued on October 15, 1973 and is to be used throughout the Republic. The species not listed are considered as unclassified.

Luxury

These decorative woods are in demand because of their attractive color contrasts, distinctive fiber arrangement, beautiful figure, pleasing aroma, hardness, adaptability to the arts, and traditional acceptance of the wood by the industry.

Cam Lai	Dalbergia bariensis
Cam Lien (Ca Gan)	Terminalia tomentosa
Cam Thi	Diospyros siamensis
Dang Huong	Pterocarpus pedatus
Gia Ty	Tectona grandis
Go Do (Ho Bi, Ca Te)	Afzelia cochinchinensis
Hue Moc	Osmanthus fragrans
Huynh Duong (Bach Duong)	Dysoxylum loureirii
Long Nao (Ra Huong, Re Huong)	Cinnamomum camphora
Mun	Diospyros mun
Muong	Cassia siamea
Ngo Tung	Keteleeria davidiana
Pe Mu	Fokienia kawai
Son	Melanorrhea laccifera
Trai	Fagraea fragrans
Trac	Dalbergia cochinchinensis

Class I

These woods are characterized by their high resistance to termites, borers, and decay. The woods are heavy, very hard, and strong. Most of these woods are used in durable construction.

Bang Lang (Sang Le, Thao Lao)	Lagerstroemia spp.
Binh Linh	Vitex pubescens
Ca Chi (Ca Chac)	Shorea obtusa
Ca Oi	Castanopsis tribuloides
Cam Xe	Xylia dolabriformis
Chai	Shorea vulgaris
Cho (Cac Loai	Parashorea stellata
Chua Khet (Lat Hoa)	Chukrassia tabularis
Chuong	Laurus camphorata
Da Da	Xylia kerrii
Giai Ngua	Swietenia macrophylla
Gioi	Talauma gioi
Go Huong	Cinnamomum illicioides
Go Mat (Gu)	Sindora cochinchinensis
Hoang Dan	Dacrydium elatum

Huynh	Tarrietia cochinchinensis
Kien Kien	Hopea pierreii
Lim	Erythrophloeum fordii
Loai Thu	Pterocarpus
May Lai	Sideroxylon eburneum
Sao	Hopea spp.
Sen	Shorea cochinchinensis
So Do (Lo Bo)	Brownlowia denysiana
So Khi	Khaya senegalensis
Thong 2 la (Ngo 2 la)	Pinus merkusii
Thong 3 la (Ngo 3 la)	Pinus kesiya
Thi	Diospyros rubra
Trai (Ly)	Garcinia fagraoides
Vang Tam	Manglietia glauca
Vang Ve	Machilus trijuga
Vap	Mesua ferrea
Xoay	Dialium cochinchinensis

Class II

This category includes wood utilized particularily in protected construction and cabinetry, because of their low resistance to decay. They are moderately heavy and cheaper than Class I woods. Some of them are the primary species for the industry; plywood, pulp, and paper. Preservative treatment is essential if these woods are used under exposed conditions.

Bac Ha	Eucalyptus spp.
Bach Tung	Podocarpus imbricatus
Bo Bo	Shorea hypochra
Bot	Pasania
Boi Loi	Litsea vang
Ca Duoi	Cyanodaphne cuneata
Chan Chan	Elaeocarpus tomentosa
Cheo	Engelhardtia chrysolepsis
Chua	Albizia stipulata
Dau Cac Loai	Dipterocarpus spp.
Dau Dong	Dipterocarpus tuberculatus
Dau Tra Beng	Dipterocarpus obtusifolius
Dau Long	Dipterocarpus intricatus
Dinh Huong	Caryophyllum aronaticus
Gao Vang	Adina cordifolia
Gie, Bop, Soi	Quercus, Pasania, Castanopsis spp.
Goi	Aglaia gigantea
Khe (Ke)	Stereospermum anamensis
Kim Giao	Podocarpus latifolia
La Hop (Sang Hop)	
Lau Tau	Vatica dyeri
Lim Xet (Hoang Lim)	Peltophorum dasyrachi
Long Muc	Wrightia anamensis
Mit Nai	Artocarpus asperula
Nao	Chukrassia

Rang Rang	Spatholobus orientalis
Re (Tru, Re Huong Va, Go Huong)	Cinnamomum spp.
Roi	Garcinia ferrea
Sang Da	Xanthophyllum colybrinum
Sang Dao	Hopea ferrea
Sau	Sandoricum indicum
Ten	Polyalthia spp.
Tram (Cac Loai)	Eugenia spp.
Ven Ven	Anisoptera cochinchinensis
Viet (Vet)	Payena elliptica
Xoai Rung	Mangifera spp.
Xoan Dao	Pygeum arboreum
Xoan Moc (Xuyen Moc)	Toona febrifuga

Class III

Most of the woods included in this category are white, soft, and light in weight. These woods are utilized in packaging, framing, and light temporary construction. They are susceptible to termites and borers.

Ba Khia	Lophopetalum wrightianum
Bang	Terminalia catappa
Bo	Hopea
Bo De	Styrax tonkinensis
Bung Bi	Capparis grandis
Cam	Parinari annamensis
Chieu Lieu	Terminalia chebula
Cham (Tram, Can Na)	Canarium nigrum
Chum Bao	Hydnocarpus anthelminthica
Coc	Spondias mangifera
Coi	Pterocaryia stenoptera
Cong	Calophyllum saigonensis
Dang De	Adina polycephala
Dung	Symplocos laurina
Du	Litsea longipes
Duong Lieu	Casuarina equisetifolia
Duoc	Rhizophora conjugata
En	
Hau Phai	Cinnamomum iners
Lanh Nganh	Cratoxylon formosum
Leo Heo	
Loi	Crypteronia paniculata
Long Mang (Mang)	Pterospermum diversifolium
Mau Cho	Knema conferta
Mo Cau	Alstonia scholaris
Mop	Alstonia spathulata
Mong Tay	
Ngat	Gironniera sinensis
Nhan Rung	Euphoria longana
Nhau	Morinda tinctoria
Nhoi	Bischofia javanica
Nhut	
Nu	Ixonanthes cochinchinensis

O Duoc	Cinnamomun zeylanicum
Oi Rung	Cratoxylon polyanthum
Ram	Anogeissus vulgaris
Sang Den	Diospyros lucida
Sang Ma (Tia)	Carallia lucida
Sang Vi	Carallia spp.
Song	Homalium meliosia
Ta Hoang	
Tram	Melaleuca leucadendron
Tre	Stenoptera
Trom	Sterculia spp.
Truong	Xerospermum macrophyllum
Tung	Tetrameles nudiflora
Vai	Nephelium litchi
Vang	Sterculia
Vang Trang	Endospermum sinensis
Vu	Litsea spp.
Vung	Careya arborea
Xu (Su)	Sapindus mukorossi

The basis for classifying a species has changed considerably over the years. Currently the higher use classifications indicate high demands and escalating values or conversely short supplies. If a low density non-durable species is in demand and commands a premium price, it will receive a high use classification. The following list indicates some of recent changes in classification that have occurred prior to October 1973. A downgrading in classification theoretically should not have occured. We can only assume that the species was originally misclassified.

From Class I to Luxury

Gia Ty	Tectona grandis
Ngo Tung	Keteleeria davidiana

From Class II to I

Bang Lang	Lagerstroemia spp.
Chai	Shorea vulgaris
Giai Ngua	Swietenia macrophylla
Gioi	Talauma gioi
Kien Kien	Hopea pierrei
Thong 3 La	Pinus kesiya
Thong 2 La	Pinus merkusii
Vang Tam	Manglietia glauca

From Class III to II

Sau	Sandoricum indicum
Ten	Polyalthia spp.

From Class II to III

Bang	Terminalia catappa
Cam	Parinari annamensis
Cong	Calpohyllum saigonensis
Truong	Pometia pinnata
Truong	Xerospermum macrophyllum

TIMBER SPECIES IN THE REPUBLIC OF VIETNAM CLASSIFIED ACCORDING TO THEIR SUITABILITY FOR 29 END USES

Many factors influence the commercial importance of any species. These include location, abundance, size of tree, consumer preferences, state of the technology, promotional exports, and even chance. The following grouping of species by uses is, of course, limited to physical and chemical characteristics as they are known today. The list was derived primarily from the literature and from personal observations. By knowing what properties are essential for a specific use, it is possible to substitute a comparable and probably more applicable use. Conversely, it is also possible to substitute species for a specific use. This latter consideration is one way of reducing the exploitation of the "preferred" species and increase the utilization of the "secondary" species.

ARCHERY BOWS

Cong	Calophyllum saigonensis
Nghien	Pentacme tonkinensis
Roi	Garcinia ferrea
Xoay	Dialium cochinchinensis

BOAT BUILDING - FRAMING

Ca Chac	Shorea obtusa
Cam Xe	Xylia dolabriformis
Chai	Shorea vulgaris
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata
Cong	Calophyllum saigonensis
Da Da	Xylia kerrii
Gu	Sindora tonkinensis
Go Mat	Sindora cochinchinensis
Kien Kien	Hopea pierreii
Lim	Erythrophyloeum fordii
May Douk	Pterocarpus pedatus
Nghien	Pentacme tonkinensis
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sen	Bassia pasquieri
Sen Mu	Shorea cochinchinensis

BOAT BUILDING - FRAMING (Continued)

Sen Mu	Shorea talura
Tau	Vatica tonkinensis
Trai Ly	Garcinia fagraoides
Tau	Vatica tonkinensis

BOAT BUILDING - PLANKING

Bang Lang	Lagerstroemia divers
Chai	Shorea vulgaris
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata
Cho Nau	Dipterocarpus tonkinensis
Dau Coc	Dipterocarpus hasseltii
Dau Con Rai	Dipterocarpus alatus
Dau Dong	Dipterocarpus tuberculatus
Dau Long	Dipterocarpus intricatus
Dau Mit	Dipterocarpus artocarpifolius
Dau Song Nang	Dipterocarpus dyerii
Dau Tra Beng	Dipterocarpus obtusifolius
Gia Ty	Tectona grandis
Gioi	Talauma gioi
Gioi	Aglaia gigantea
Kien Kien	Hopea pierreii
Sang Dao	Hopea ferrea
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sen Mu	Shorea talura
Sen Mu	Shorea cochinchinensis
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula

BOAT BUILDING - OARS AND RUDDERS

Bang Lang	Lagerstroemia divers
Cam Xe	Xylia dolabriformis
Chai	Shorea vulgaris
Chieu Lieu	Terminalia chebula
Cho Chi	Parashorea densiflora
Huynh	Tarrietia cochinchinensis
Kien Kien	Hopea pierreii
Sao	Hopea dealbata
Tau	Vatica tonkinensis
Vap	Mesua ferrea
Xoay	Dialium cochinchinensis
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata

BUOYS

Quao	Dolichandrone rheedii
Tung	Tetrameles nudiflora
Vong	Unclassified

CABINETS

Bang Lang	Lagerstroemia divers
Bang Lang Khe	Terminalia tomentosa
Boi Loi	Litsea vang
Bot, Gie, Soi, Lim	Quercus and Pasania spp.
Cac Loai	Parashorea stellata
Cam Lai	Dalbergia bariensis
Cam Thi	Diospyros siamensis
Chieu Lieu	Terminalia catappa
Chieu Lieu	Terminalia chebula
Chieu Lieu	Terminalia ivorensis
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cui	Tarrietia littoralis
Dinh	Markhamia stipulata
Du	Litsea longipes
Gia Ty	Tectona grandis
Gioi	Talauma gioi
Go Do	Afzelia cochinchinensis
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Huynh	Tarrietia cochinchinensis
Kien Kien	Hopea pierreii
Lat Hoa	Chukrassia tabularis
May Douk	Pterocarpus pedatus
Mit Nai	Artocarpus asperula
Mit Nai	Artocarpus hirsuta
Mit Nai	Artocarpus integrifolia
Muong	Cassia siamea
Mun	Diospyros mun
Quach	Dalbergia nigrescens
San	Bassia pasquieri
San Dao	Hopea ferrea
Sao	Hopea dealbata
Sao Den	Hopea odorata
Son	Melanorrhea laccifera
Trac	Dalbergia cochinchinensis
Trai	Garcinia fagroides
Vang Tam	Manglietia glauca
Vap	Mesua ferrea
Xoan Dao	Pygeum arboreum
Xoan Moc	Toona febrifuga

CHOPPING BLOCKS

Me	Tamarindus indica
Nghien	Pentacme tonkinensis
Nhan	Euphora longana
Sen	Bassia pasquieri
Vai	Nephelium litchi
Xoai Hoi	Mangifera indica
Xoai Queo	Mangifera forida

CROSS TIES - UNTREATED

Ca Chac	Shorea obtusa
Ca Duoi	Cyanodaphne cuneata
Cam Xe	Xylia dolabriformis
Chai	Shorea vulgaris
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata
Cho Nau	Dipterocarpus tonkinensis
Cong	Calophyllum saigonensis
Da Da	Xylia kerrii
Dau Coc	Dipterocarpus hasseltii
Dau Con Rai	Dipterocarpus alatus
Dau Dong	Dipterocarpus tuberculatus
Dau Long	Dipterocarpus intricatus
Dau Mit	Dipterocarpus artocarpifolius
Dau Song Nang	Dipterocarpus dyerii
Dau Tra Beng	Dipterocarpus obtusifolius
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Kien Kien	Hopea pierreii
Lau Tau	Vatica dyerii
Lim	Erythrophloeum fordii
Nghien	Pentacme tonkinensis
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sen	Bassia pasquieri
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
Tau	Vatica tonkinensis
Trai Ly	Garcinia fagraoides
Vap	Mesua ferrea
Xoay	Dialium cochinchinensis

FLOORING

Bot, Gie, Soi, Lim	Quercus and Pasania spp.
Ca Chac	Shorea obtusa
Chai	Shorea vulgaris

FLOORING (Continued)

Cui	Tarrietia littorales
Gioi	Talauma gioi
Gioi	Michelia bariensis
Gioi	Michelia longipes
Huynh	Tarrietia cochinchinensis
Sao Den	Hopea odorata
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
So	Dillenia aurea
So	Dillenia elata
Trai	Fagraea fagrans
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Viet	Payena elliptica

FRAMING - DECAY RESISTANT WHEN EXPOSED

Ca Chac	Shorea obtusa
Ca Oi	Castanopsis indica
Ca Oi	Castanopsis tribuloides
Cac Loai	Parashorea stellata
Cam Xe	Xylia dolabriformis
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Da Da	Xylia kerrii
Dinh	Markhamia stipulata
Gia Ty	Tectona grandis
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Kien Kien	Hopea pierreii
Lat Hoa	Chukrassia tabularis
Lau Tau	Vatica dyerii
Lim	Erythrophloeum fordii
May Douk	Pterocarpus pedatus
Mit	Artocarpus integrifolia
Nghien	Pentacme tonkinensis
Pe Mu	Fokienia hodginsii
Pe Mu	Fokienia kawai
Sang	Eugenia tinctoria
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sen Bo Bo	Shorea hypochra
Tau	Vatica tonkinensis
Trai	Garcinia fagraoides

FRAMING - DECAY RESISTANT WHEN EXPOSED (Continued)

Vap	Mesua ferrea
Vet	Payena elliptica
Xoay	Dialium cochinchinensis

FRAMING - NOT RESISTANT TO DECAY UNLESS PROTECTED

Ba Khia	Lophopetalum wrightianum
Bang Lang	Lagerstroemia divers
Binh Linh	Vitex pubescens
Boi Loi	Litsea vang
Bot, Gie, Soi, Lim	Quercus and Pasania spp.
Ca Duoi	Cyanodaphne cuneata
Ca Na	Canarium album
Cam	Parinari annamensis
Chai	Shorea vulgaris
Cham	Canarium nigrum
Cham Trang	Canarium copaliferum
Cheo	Engelhardtia chrysolepis
Chieu Lieu	Terminalia chebula
Chieu Lieu	Terminalia ivorensis
Chieu Lieu	Terminalia catappa
Cho Nau	Dipterocarpus tonkinensis
Cong	Calophyllum divers
Cong	Calophyllum saigonensis
Cui	Tarrietia littoralis
Dau	Morus indica
Du	Litsea longipes
Gioi	Talauma gioi
Go Huong	Cinnamomum illiciodes
Goa	Bombax malabaricum
Goi	Aglaia gigantea
Hap	Vitex sumatrana
Hau Phat	Cinnamomum iners
Huynh	Tarrietia cochinchinensis
Lim Xet	Peltophorum dasyrachi
Lim Xet	Peltophorum ferrugineum
Long Nao	Cinnamomum camphora
Nhoi	Bischofia javanica
O Duoc	Cinnamomum zelanicum
Re	Cinnamomum divers
Re Huong	Cinnamomum obtusifolium
Sang Dao	Hopea ferrea
Sang Ma	Carallia lucida
Sang Trang	Lophopetalum duperreanum
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
Soi Bop	Pasania fissa

FRAMING - NOT RESISTANT TO DECAY UNLESS PROTECTED (Continued)

Thau	Liquidambar formosama
Thuong	Pometia pinnata
Xoan	Melia azaderach
Xoan	Melia divers
Xoan Dao	Pygeum arboreum
Xoan Moc	Toona febrifuga

FURNITURE

Ba Khia	Lophopetalum wrightianum
Bang Lang	Lagerstroemia divers
Boi Loi	Litsea vang
Ca Chac	Shorea obtusa
Ca Na	Canarium album
Cam Lai	Dalbergia bariensis
Chai	Shorea vulgaris
Cham	Canarium nigrum
Cham Trang	Canarium copaliferum
Chieu Lieu	Terminalia chebula
Cong	Calophyllum divers
Cong	Calophyllum saigonensis
Cui	Tarrietia littoralis
Dang De	Adina polycephala
Dang Huong	Pterocarpus pedatus
Gao Dang De	Adina cordifolia
Gia Ty	Tectona grandis
Gioi	Talauma gioi
Go Do	Afzelia cochinchinensis
Go Mat	Sindora cochinchinensis
Goa	Bombax malabaricum
Goi	Aglaia gigantea
Gu	Sindora tonkinensis
Huynh	Tarrietia cochinchinensis
Huynh Duong	Dysoxylum loureirii
Lim Xet	Peltophorum ferrugineum
Ly	Garcinia fagraoides
Me Tay	Samanea saman
Mit Nai	Artocarpus hirsuta
Mu U	Calophyllum inophyllum
Nghien	Pentacme tonkinensis
Ngo Tung	Keteleeria davidiana
Quach	Dalbergia nigrescens
Sang Trang	Lophopetalum duperreanum
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sau Do	Sandoricum indicum
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis

FURNITURE (Continued)

So	Dillenia aurea
So	Dillenia elata
Trac	Dalbergia cochinchinensis
Vap	Mesua ferrea
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Viet	Payena elliptica
Xoai Hoi	Mangifera indica
Xoai Queo	Mangifera forida
Xoan Dao	Pygeum arboreum
Xoan Moc	Toona febrifuga

GENERAL CONSTRUCTION

Ban Xe	Albizia lucida
Boi Loi	Litsea vang
Bot, Gie, Soi, Lim	Quercus and Pasania spp.
Ca Chac	Shorea obtusa
Ca Oi	Castanopsis indica
Co Oi	Castanopsis tribuloides
Cam Xe	Xylia dolabriformis
Chai	Shorea vulgaris
Cho Nau	Dipterocarpus tonkinensis
Cong	Calophyllum divers
Cong	Calophyllum saigonensis
Da Da	Xylia kerrii
Dau Cac	Dipterocarpus hasseltii
Dau Con Rai	Dipterocarpus alatus
Dau Long	Dipterocarpus intricatus
Dau Mit	Dipterocarpus articarpifolius
Dau Son	Dipterocarpus tuberculatus
Dau Song Nan	Dipterocarpus dyerii
Dau Tra Beng	Dipterocarpus obtusifolius
Du	Litsea longipes
Gia Ty	Tectona grandis
Gioi	Michelia bariensis
Gioi	Michelia mediocris
Gioi	Talauma gioi
Goa	Bombax anceps
Goa	Bombax malabaricum
Go Do	Afzelia cochinchinensis
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Kien Kien	Hopea pierreii
Lanh Nganh	Cratoxylon formosum
Mit	Artocarpus integrifolia
Mit Nai	Artocarpus asperula

Mit Nai	Artocarpus hirsuta
Mu U	Calophyllum inophyllum
Nghien	Pentacme tonkinensis
Nhoi	Bischofia javanica
San	Bassia pasquieri
Sang	Eugenia tinctoria
Sang Dao	Hopea ferrea
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
So	Dillenia aurea
So	Dillenia elata
Thau	Liquidambar formosama
Trai	Fagraea fagrans
Trai	Garcinia fagraoides
Truong	Pometia pinnata
Truong	Xerospermum macrophyllum
Vap	Mesua ferrea
Ven Ven	Anisoptera cochincninensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Viet	Payena elliptica
Xoan	Melia azaderach
Xoay	Dialium cochinchinensis

HATS

Cac Ban	Sonneratia acida
Dien Dien	Unclassified
Dut	Unclassified
Mo Cua	Alstonia scholaris
Mop	Alstonia spathulata

MATCHES

Bach Tung	Podocarpus imbricatus
Bo De	Styrax benzoin
Bo De	Styrax tonkinensis
Cao Su	Hevea braziliensis
Cham	Canarium nigrum
Cham Trang	Canarium copaliferum
Gao Trang	Anthocephalus indices
Go Huong	Cinnamomum illiciodes
Hau Phat	Cinnamomum iners
Kim Giao	Podocarpus latifolia
Muong Tia	Cassia timoriensis
Ngo Tung	Keteleeria davidiana
O Duoc	Cinnamomum zeylanicum

MATCHES (Continued)

Re Huong	Cinnamomum obtusifolium
Re Huong	Cinnamomum camphora
Thong Tre	Podocarpus cupressina
Vang	Mallotus cochinchinensis

MATCH BOXES

Bo De	Styrax benzoin
Bo De	Styrax tonkinensis
Mau Cho	Knema conferata
Mo Cua	Alstonia scholaris
Mo Cua	Alstonia spathulata
Sang Mau	Knema corticosa
Vang	Mallotus cochinchinensis

MILLWORK

Bang Lang	Lagerstroemia divers
Bo Bo	Shorea hypochra
Boi Loi	Litsea vang
Ca Chac	Shorea obtusa
Chai	Shorea vulgaris
Cheo	Engelhardtia chrysolepsis
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata
Cho Nau	Dipterocarpus tonkinensis
Cong	Calophyllum divers
Cong	Calophyllum saigonensis
Cui	Tarrietia littoralis
Dau Coc	Dipterocarpus hasseltii
Dau Con Rai	Dipterocarpus alatus
Dau Dong	Dipterocarpus tuberculatus
Dau Long	Dipterocarpus intricatus
Dau Mit	Dipterocarpus artocarpifolius
Dau Song Nang	Dipterocarpus dyerii
Dau Tra Beng	Dipterocarpus obtusifolius
Gao	Anthocephalus cadamba
Gia Ty	Tectona grandis
Gie, Soi, Bot, Lim	Quercus and Pasania spp.
Gioi	Talauma gioi
Gioi	Michelia bariensis
Gioi	Michelia mediocris
Hau Phat	Cinnamomum iners
Huynh	Tarrietia cochinchinensis
Lat Hoa	Chukrassia tabularis
Lim Xet	Peltophorum dasyrachi
Lim Xet	Peltophorum paniculata
Me Tay	Samanea saman

Mit Nai	Artocarpus hirsuta
Mo Cua	Alstonia scholaris
Mo Cua	Alstonia spathulata
Mo Vang Tam	Manglietia glauca
Mu U	Calophyllum inophyllum
Nghien	Pentacme tonkinensis
Nong Heo	Holoptera integrifolia
O Duoc	Cinnamomum zeylanicum
Re	Cinnamomum divers
Re Huong	Cinnamomum camphora
Re Huong	Cinnamomum obtusifolium
Sang Ma	Carallia lucida
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sau	Sandoricum indicum
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
Soi Bop	Pasania fissa
Son	Melanorrhea laccifera
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Viet	Payena elliptica
Xoan	Melia azaderach
Xoan Dao	Pygeum arboreum
Xoan Moc	Toona febrifuga

MORTARS AND PESTLES

Buoi	Unclassified
Me	Tamarindus indica
Mu	Calophyllum inophyllum
Nghien	Pentacme tonkinensis
Oi Rung	Cratoxylon polyanthum
Thau	Liquidambar formosama
Sao	Hopea dealbata
Sao Den	Hopea odorata
Xoay	Dialium cochinchinensis
Xoai Hoi	Mangifera indica
Xoai Queo	Mangifera forida

MUSICAL INSTRUMENTS

Sung	Ficus spp.
Vong	Unclassified

PACKAGING

Ba Khia	Lophopetalum wightianum
Bop	Pasania fissa
Cam	Parinari annamensis
Cham	Canarium nigrum
Cham Trang	Canarium copaliferum
Cheo	Engelhardtia chrysolepsis
Ca Na	Canarium album
Cong	Callophyllum divers
Cong	Callophyllum saigonensis
Coi	Pterocaryia stenoptera
Goa	Bombax malabaricum
Goa	Bombax anceps
Long Muc	Wrightia annamensis
Muong Tia	Cassia timoriensis
Muong Trang	Cassia tonkinensis
My	Lysidice rhodostegia
Phay	Duabanga sonneratioides
Rang Rang	Spatholobus orientalus
Sang Trang	Lophopetalum duperreanum
Sau	Sandoricum indicum
Sui	Antiaris toxicaria
Sung	Ficus spp.
Tung	Tetrameles nudiflora
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Xoan	Melia azaderach

PENCILS

Sau	Sandoricum indicum

PICTURE FRAMES

Loi Tho	Gmelina arborea
Tung	Tetrameles nudiflora

POSTS AND PILINGS - UNTREATED

Binh Linh	Vitex pubescens
Ca Chac	Shorea obtusa
Ca Duoi	Cyanodaphne cuneata
Cam Xe*	Xylia dolabriformis
Cong	Calophyllum saigonensis
Da Da*	Xylia kerrii

* Very durable and resistant to teredo.

Duoc (Mangrove)	Rhizophora spp.
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Hap	Vitex sumatrana
Khe*	Stereospermum annamensis
Kien Kien	Hopea pierreii
Lau Tau*	Vatica dyerii
Lim	Erythrophloeum fordii
Nghien	Pentacme tonkinensis
Sang Dao	Hopea ferrea
Sao	Hopea dealbata
Sao Den	Hopea odorata
Tau*	Vatica tonkinensis
Trai Ly	Garcinia fagraoides
Tram (Rear Mangrove)	Melaleuca leucadendron
Vap*	Mesua ferrea
Vet (Mangrove)	Bruguiera spp.
Xoay	Dialium cochinchinensis

* Very durable and resistant to teredo.

PROPELLORS

Bang Lang	Lagerstroemia divers
Boi Loi	Litsea vang
Gioi	Talauma gioi
Goi	Aglaia gigantea

RIFLE STOCKS

Gioi	Talauma gioi

SCULPTURE, CARVINGS AND INLAY

Bang Lang	Lagerstroemia divers
Binh Linh	Vitex pubescens
Boi Loi	Litsea vang
Cam Lai	Dalbergia bariensis
Cam Thi	Diospyros siamensis
Dinh	Markhamia stipulata
Gao	Anthocephalus cadamba
Gioi	Talauma gioi
Go Do	Afzelia cochinchinensis
Go Huong	Cinnamomum illiciodes
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Hap	Vitex sumatrana
Hau Phat	Cinnamomum iners

SCULPTURE, CARVINGS AND INLAY (Continued)

Huynh Duong	Dysoxylon loureirii
Lat Hoa	Chukrassia tabularis
Long Muc	Wrightia annamensis
Mit	Artocarpus integrifolia
Muong	Cassia siamea
Mo Vang Tam	Manglietia glauca
Mun	Diospyrus mun
Nghien	Pentacme tokinensis
O Duoc	Cinnamomum zeylanicum
Re	Cinnamomum divers
Re Huong	Cinnamomum camphora
Re Huong	Cinnamomum obtusifolium
Sang Da	Xanthophyllum cochinchinensis
Son	Melanorrhea laccifera
Trac	Dalbergia cochinchinensis
Trai Ly	Garcinia fagraoides

SHOES

Long Muc	Wrightia annamensis
Mo Cua	Alstonia scholaris
Mop	Alstonia spathulata
Sang Trang	Lophopetalum duperreanum
Sau	Sandoricum indicum
Tung	Tetrameles nudiflora
Vang	Mallotus cochinchinensis
Vong	Unclassified

TOOL HANDLES

Bang Lang	Lagerstroemia divers
Boi Loi	Litsea vang
Bot, Gie, Soi, Lim	Quercus and Pasania spp.
Chieu Lieu	Terminalia chebula
Cong	Calophyllum saigonensis
Goi	Aglaia gigantea
Huynh	Tarrietia cochinchinensis
Kien Kien	Hopea pierrei
Lim	Erythrophloeum fordii
Nghien	Pentacme tonkinensis
Roi	Garcinia ferrea
Sao	Hopea dealbata
Sen	Bassia pasquieri
Thoi Chanh	Unclassified
Truong	Pometia pinnata

TRUNKS, CHESTS AND COFFINS

Boi Loi	Litsea vang
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata
Du	Litsea longipes
Gioi	Talauma gioi
Goi	Aglaia gigantea
Go Huong	Cinnamomum illiciodes
Hau Phat	Cinnamomum iners
Huynh Duong	Dysoxylum loureirii
Kien Kien	Hopea pierrei
May Douk	Pterocarpus pedatus
Mo Vang Tam	Manglietia glauca
O Duoc	Cinnamomum zeylanicum
Pe Mu	Fokienia hodginsii
Pe Mu	Fokienia kawai
Re	Cinnamomum divers
Re Huong	Cinnamomum camphora
Re Huong	Cinnamomum obtusifolium
Samou	Cunninghamia sinensis
Sao	Hopea dealbata
Sao Den	Hopea odorata
Trai Ly	Garcinia fagraoides
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Xoan	Melia azaderach
Xoan	Melia divers
Xoan Moc	Toona febrifuga

TURNINGS

Cho Nau	Dipterocarpus tonkinensis
Dau Coc	Dipterocarpus hasseltii
Dau Con Rai	Dipterocarpus alatus
Dau Dong	Dipterocarpus tuberculatus
Dau Long	Dipterocarpus intricatus
Dau Mit	Dipterocarpus artocarpifolius
Dau Song Nang	Dipterocarpus dyerii
Dau Tra Beng	Dipterocarpus obtusifolius
Dinh	Markhamia stipulata
Gioi	Talauma gioi
Go Mat	Sindora cochinchinensis
Gu	Sindora tonkinensis
Long Muc	Wrightia annamensis
Mit Nai	Artocarpus integrifolia

VEHICLE FRAMES, WHEELS AND AXLES

Bang Lang	Lagerstroemia divers
Binh Linh	Vitex pubescens
Ca Cha	Shorea obtusa
Cam Xe	Xylia dolabriformis
Chai	Shorea vulgaris
Chieu Lieu	Terminalia chebula
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida
Cho Chi	Parashorea stellata
Cui	Tarrietia littoralis
Da Da	Xylia kerrii
Gie, Bot, Soi, Lim	Quercus and Pasania spp.
Goi	Aglaia gigantea
Huynh	Tarrietia huynh
Khe	Stereospermum annamensis
Kien Kien	Hopea pierreii
Lim	Erythrophloeum fordii
May Douk	Pterocarpus pedatus
Sang Ma	Carallia lucida
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sen	Bassia pasquieri
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
Vap	Mesua ferrea
Xoan Dao	Pygeum arboreum
Xoay	Dialium cochinchinensis

VENEER AND PLYWOOD

Ba Khia	Lophopetalum wrightianum
Bach Duong	Dysoxylum loureirii
Bach Tung	Podocarpus imbricatus
Ban Xe	Albizia lucida
Bot, Gie, Soi, Lim	Quercus and Pasania spp.
Ca Chac	Shorea obtusa
Cac Loai	Parashorea stellata
Ca Na	Canarium album
Cam Lien	Terminalia tomentosa
Cam Thi	Diospyros siamensis
Chai	Shorea vulgaris
Cham	Canarium nigrum
Cham Trang	Canarium copaliferum
Chieu Lieu	Terminalia catappa
Chieu Lieu	Terminalia chebula
Chieu Lieu	Terminalia ivorensis
Cho Chi	Parashorea densiflora
Cho Chi	Parashorea lucida

Cho Nau	Dipterocarpus tonkinensis
Chau	Albizia stipulata
Cong	Calophyllum divers
Cong	Calophyllum saigonensis
Cui	Tarrietia littoralis
Dang De	Adina polycephala
Dau Coc	Dipterocarpus hasseltii
Dau Con Rai	Dipterocarpus alatus
Dau Dong	Dipterocarpus tuberculatus
Dau Long	Dipterocarpus intricatus
Dau Mit	Dipterocarpus articarpifolius
Dau Song Nan	Dipterocarpus dyerii
Dau Tra Beng	Dipterocarpus obtusifolius
Duong Lieu	Casuarina equisetifolia
Gao Vang	Adina cordifolia
Gia Ty	Tectona grandis
Gioi	Michelia bariensis
Gioi	Michelia mediocris
Go Mat	Sindora cochinchinensis
Goa	Bombax anceps
Goa	Bombax malabaricum
Gu	Sindora tonkinensis
Huynh	Tarrietia cochinchinensis
Kien Kien	Hopea pierreii
Kim Giao	Podocarpus latifolia
Lat Hoa	Chukrassia tabularis
Lau Tau	Vatica dyerii
Loi Tho	Gmelina arborea
Mau Cho	Knema conferta
Me Tay	Samanea saman
Mit	Artocarpus integrifolia
Mit Nai	Artocarpus asperula
Mit Nai	Artocarpus hirsuta
Mu U	Calophyllum inophyllum
Mun	Diospyros mun
Nong Heo	Holoptelea integrifolia
Sang Dao	Hopea ferrea
Sang Den	Diospyros lucida
Sang Mau	Knema corticosa
Sang Trang	Lophopetalum duperreanum
Sao	Hopea dealbata
Sao Den	Hopea odorata
Sen Bo Bo	Shorea hypochra
Sen Mu	Shorea cochinchinensis
Sen Mu	Shorea talura
So	Dillenia aurea
So	Dillenia elata
Sua	Albizia lebbekoides
Tau Mat	Vatica tonkinensis

Thau	Liquidambar formosama
Thi	Diospyros rubra
Thong Tre	Podocarpus cupressina
Thong	Podocarpus fleuryi
Truong	Pometia pinnata
Tung	Tetrameles nudiflora
Vang	Sterculia lychnophora
Vang Trang	Endospermum sinensis
Vang Ve	Machilus trijuga
Ven Ven	Anisoptera cochinchinensis
Ven Ven	Anisoptera glabra
Ven Ven	Anisoptera oblonga
Ven Ven	Anisoptera scaphula
Vet	Payena elliptica
Voi	Sterculia pexa

APPENDIX D. A PROPOSAL FOR EVALUATING SOUTH VIETNAM'S FOREST RESOURCES FOR UTILIZATION

Dr. Earl P. Stevens of the University of Florida has suggested that the small wood testing effort at the College of Forestry in Saigon be intensified as part of an expanded forest products curriculum and research program. Both research and training must be expanded if technical information about Vietnam species is to be rapidly improved. Basic to these needs is the establishment of a competently staffed and fully equipped forest products laboratory.

The following remarks concern what wood properties should be studied and how the problem might be approached. The discussion certainly is not all inclusive and mentions some areas that might be beyond the capacity of South Vietnam at the present time. However, it does provide a base from which to start.

The large number of tree species on a given area of forest land presents several problems as to the intelligent utilization of these species. The physical, mechanical, and machining properties of many of these species are unknown. On the other hand, there often is not a significant volume of any one species to provide for its economical utilization. By initiating a full-scale testing program, species characterization will define probable areas for utilization. It will also provide a base for grouping low-volume secondary species with similar properties so they can be substituted for currently accepted, well-documented, and often over-exploited species.

The economic utilization of wood demands a thorough knowledge of its properties. Studies to determine these properties must be conducted very carefully and full consideration must be given to the sampling scheme, test methods, and wood properties to be tested.

SAMPLING SCHEME

Sampling of wood specimens in the forest should be combined with the scheduled forest inventory; both projects have high priorities and can be executed simultaneously. Forest inventories are basic to estimating the product potential of standing timber. Not only must you know how much you have, but how much of what and its characteristics.

Inventories are relatively expensive and require large, well-trained staffs. The addition of one or two personnel to inventory teams to collect test specimens, with a minimum amount of equipment, will avoid a duplication of cost and effort. Forest inventories and wood specimen sampling are highly compatible since both require a sound statistical sample that is representative of the forest resource. Both also assume some knowledge of the range and distribution of the species so the appropriate statistical method can be used.

Characteristics of sampling for standard testing procedures are summarized as follows:

1) Random statistical sampling must be properly executed to provide both reliable estimates of the mean values and the variability about the mean. This sampling should be conducted in three stages: sample growth areas across the entire geographical distribution of the species, each weighted according to its importance; sample trees within each growth area; and sample specimens within each tree.

2) Random sampling has the advantage of being progressive. By additional sampling, the accuracy of the mean values can be improved and the variability about the mean reduced.

3) The size of the sample depends upon the variability of the respective property and the precision with which one desires to estimate the species mean. It also depends upon the relative cost of sampling in the forest and in the laboratory. Consequently, it can be said to be an optimizing problem dependent upon the individual limitations placed upon it.

The accurate range of the mean values, as a rule-of-thumb, should probably be in the vicinity of $\pm$ 5 percent.

TEST METHODS

Uniform test methods that have been standardized internationally are a prerequisite for obtaining test results in different laboratories and countries, if they are to be compatible with one another.

The Food and Agricultural Organization of the United Nations (FAO) is active in encouraging programs for evaluating tropical hardwoods. The International Union of Research Organizations (IUFRO) also has group working on tropical hardwood evaluation. The International Standardization Organization (ISO) and the American Society of Testing Materials (ASTM) are two organizations that continually standardize test methods. The methods, terminology, and units of measurement mentioned in this text (particularly for the mechanical properties) are in accordance with ASTM D-2555, "Standard Methods of Testing Small Clear Specimens of Timber."

The units of measurements applicable to the physical and machining properties are more subjective in nature and are commonly used by individuals and laboratories in the United States.

WOOD PROPERTIES

Physical Properties

Physical properties include:

•Specific gravity, or the ratio of the weight of a given volume of wood to that of an equal volume of water at a standard temperature. These values are normally based on the weight of wood when oven-dry and its volume when green (or a 12 to 15 percent moisture content).

• Total shrinkage, a percentage expressing the total shrinkage from green to oven-dry condition. It is usually measured in three dimensions when green: radial, tangential, and volumetric.

• Moisture content, the weight of the water contained in the wood expressed as a percentage of the weight of the oven-dry wood.

• Natural durability, expressed as excellent, good, fair, or poor.

• Permeability of preservatives (i.e., permeable, moderately permeable, or refractory).

• Grain (noted as straight, interlocked, or irregular).

• Texture (fine, medium, coarse).

• Abrasion resistance (excellent, good, fair, poor).

• Glueability (excellent, good, fair, poor).

• Finishing (excellent, good, fair, poor).

• Tension wood (noted if present).

• Silica (noted if present).

• Irritating sawdust (noted if present).

• Seasoning (provide kiln schedule).

• Oil (noted if present).

Mechanical Properties

Mechanical properties include:

• Static bending

Modulus of rupture (noted in pounds per square inch). This is a measure of the ability of a beam to support a slowly applied load for a short time.

Modulus of elasticity (indicated in 1,000 pounds per square inch). It is a measure of stiffness or rigidity. For a beam, the modulus of elasticity is a measurement of its resistance to deflection.

Work to maximum load (shown as inch pounds per cubic inch). This represents the ability of the timber to absorb shock with some permanent deformation. These are measures of the combined strength and toughness of wood under bending stresses.

• Compression

Parallel to grain or maximum crushing strength (pounds per square inch). This is the maximum stress sustained by a compression specimen having a length to thickness ratio of less than 11 under a load applied parallel to the grain. This property permits evaluation of the strength of posts or short blocks.

Perpendicular to grain or fiber stress at proportional limit (pounds per square inch). This is the maximum across-the-grain stress that can be applied for a few minutes through a plate covering only a portion of a timber surface without causing injury to the timber.

• Shear parallel to grain or maximum shear stress (pounds per square inch). This is a measure of the ability of timber to resist slipping of one part upon another along the grain.

• Tension perpendicular to grain (pounds per square inch). This measures the wood's resistance to forces acting across the grain; these tend to split a member.

• Hardness (pounds). These are the pounds required to imbed a 0.444-inch steel ball to half its diameter. It represents the resistance of wood to wear and marring. The values are expressed as either representing the end or side, or as the average of the two.

• Toughness (indicated in inch pounds). This measures the ability to absorb shock or impact loads.

Machining Properties, which include:

• Planing (shown as a percentage of defect free pieces).

• Shaping .

• Turning .

• Boring (expressed as a percentage of excellent, good, fair, and poor pieces).

• Mortising .

• Sanding .

• Steam bending (noted as percentage of pieces unbroken).

• Nail splitting (noted as percentage of pieces free from complete splits).

• Screw splitting (noted as percentage of pieces free from complete splits).

DISCUSSION

The foregoing is a rather lengthy listing of wood properties which are considered important in the utilization of a species. To study all of them would be an enormous task. Consequently, it is useful to establish some priorities according to anticipated end use of the wood. Specific gravity and compression parallel to the grain are two tests generally considered satisfactory for initial screening purposes. Some properties are strongly correlated with others. An example is the strong correlation between specific gravity and hardness, abrasion resistance, and compression parallel to grain. Modulus of rupture is strongly correlated with modulus of elasticity. The latter correlation is an important consideration, since the determination of modulus of elasticity generally requires more sensitive instrumentation than modulus of rupture.

Because of the correlation between the properties of green and conditioned wood it is often sufficient to determine the properties in the green specimen only. This would greatly expedite testing by reducing or possibly eliminating the drying as well as reducing the possibility of incurring drying defects and loss of material to decay and insects.

It is suggested that some caution be applied to the foregoing correlations. They are only mentioned for consideration and not necessarily suggested as a course of action. A complete understanding of them is necessary for their intelligent application.

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APPENDIX E. THE INVESTMENT OPPORTUNITY IN SEVERAL SOUTH VIETNAM TIMBER DEVELOPMENT OPTIONS

General financial analyses were made for nine different types or sizes of wood manufacturing plants in the course of evaluating the investment opportunities for timber industry development in South Vietnam. Four plants--a medium-size sawmill, a rotary plywood mill, a sliced veneer plywood plant, and a particleboard plant--were analyzed both individually and together as an industrial complex. Investment calculations were also made for three smaller size sawmills and for wood chipping plants of two different sizes.

None of these calculations should be regarded as cost-feasibility studies such as are made for proposed plants at specific locations for which the various cost elements have been identified. Such in-depth analyses would have required, for one thing, fairly detailed information regarding the volume, quality, and species composition of the timber available as well as reliable estimates of wood procurement costs as related to particular plant sites. Information of this type was not available. The purpose here has been to indicate the general level of investment opportunities.

Since October 1973, when the analyses were made, wood product prices have risen. As this is written there is no indication as to where prices will stabilize. However, there is no indication, either, that the changes that have taken place materially alter the investment opportunities the following calculations describe.

HARDWOOD UTILIZATION COMPLEX

Sawmill

1.	Capital investment	$1,126,999
2.	Annual lumber sales (33,000 cubic meters @ $85)	2,805,000
	Annual production costs	2,184,237
	Gross annual profit	620,763
3.	Profit return on sales =22 percent	
	Annual profit return on investment =55 percent	
4.	119 employees	
	714 man days per 1,000 cubic meters of logs processed	

5. Details of annual costs:

Unskilled workers	78	@ $1.40/day x 300	$32,760
Semiskilled workers	8	@ 2.80/day x 300	6,720
Skilled workers	25	@ 4.20/day x 300	31,500
Foremen	4	@ 4.40/day x 300	5,280
Manager	1	@ Salary	12,000
Office staff	3	@ 2.50/day x 300	2,250
25% benefits			22,627
Total labor	119		$113,137

Logs (50,000 cubic meters @ $40)	$2,000,000
Parts and supplies	4,000
Power	9,000
Depreciation	42,100
Fixed costs	16,000
Total costs	$2,184,237

6. Details of Sawmill investment in equipment and building:

Barker	$30,000
Log rollways	5,000
Chain saws	3,000
Hoists	20,000
Fork lift 10 ton	46,000
Metal detector	9,000
60" log band mill	12,793
60" auto feed carriage	21,987
54" log band mill	11,266
54" auto feed carriage	19,953
8 - 42" table resaws	25,766
2 - 48" table resaws	2,700
2 - 36" swing saws	921
Auto band saw sharpener	4,161
Band saw stretcher	766
Band saw brazing clamp	186
Conveyors and rolls	20,000
Fork lift truck 5 ton	25,000
Sawdust collection system	30,000
Carriage rails and etc.	3,000
Electric wiring and transformers	9,500
Installation costs	26,000
Freight on equipment	29,000
Site preparation	17,000
Paving--black top	4,000
Building	40,000
Office and equipment	10,000
Total plant and equipment	$426,999
Working capital	700,000
Total investment	$1,126,999

Rotary Plywood Plant

1.	Capital investment	$2,986,000
2.	Annual plywood sales (25,000 cubic meters @ $144)	3,600,000
	Annual production costs	2,567,166
	Gross annual profit	1,032,800

3. Profit return on sales = 29 percent
   Profit return on investment = 35 percent

4. 160 employees
   960 man days per 1,000 cubic meters of logs processed

5. Details of annual costs:

Unskilled workers	72	@ $1.40/day x 300	$30,240
Semiskilled workers	61	@ 3.60/day x 300	65,880
Skilled workers	18	@ 4.20/day x 300	22,680
Foreman	5	@ 4.40/day x 300	6,600
Manager	1	@ Annual salary	12,000
Office staff	3	@ 2.50/day x 300	2,250
25% benefits			34,912
Total labor	160		$174,562

Logs (50,000 cubic meters @ $40)	$2,000,000
Glue	120,000
Parts and supplies	20,000
Power	15,000
Depreciation	212,600
Fixed costs	25,000
Total costs	$2,567,162

6. Details of rotary plywood plant investment
   in equipment and building:

Barker	$30,000
Metal detector	9,000
Lathe	114,000
D. C. drives	38,000
Charger and etc.	35,000
Tray system	24,000
Clipper	14,000
Dryer	124,000
Feeder and unloader	28,000
Moisture detector	10,000
Grading belt	1,500
Jointer	20,000
Splicers	30,000
Veneer plugger	18,000
Glue spreaders	20,000
Pre-press	60,000

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Hot press	$120,000
Loader	30,000
Unloader	15,000
Saw-line	28,000
Sander	90,000
Blower system	30,000
Specialty saw	10,000
Strapper	1,000
Core saw	2,500
Block saw	5,000
Fuel hog	10,000
Chipper	15,000
4 - Fork lift trucks	28,000
1 - Log fork lift truck	20,000
Glue mixer and tanks	12,000
Equipment cost	$992,000
Freight, 10%	99,000
Installation	98,000
Site preparation	95,000
Press pit and foundations	
Building	
Boiler plant	
Piping	
Power hookup	
Estimated cost	940,000
Total plant and equipment	$2,224,000
Working capital	762,000
Total investment	$2,986,000

Sliced Veneer Plywood Plant

1. Capital investment $2,408,000

2. Annual plywood sales (20,250 cubic meters @ $144) 2,916,000
   Annual production costs 1,943,988
   Gross annual profit 972,012

3. Profit return on sales 33 percent
   Annual profit return on investment 40 percent

4. 116 employees
   1,392 man days per 1,000 cubic meters of logs processed

5. Details of annual costs:

Unskilled workers	62 @	$1.40/day x 300	26,040
Semiskilled workers	40 @	3.60/day x 300	43,200
Skilled workers	7 @	4.20/day x 300	8,820
Foremen	3 @	4.40/day x 300	3,960
Manager	1 @	Annual salary	12,000

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Office staff	3 @ $2.50/day x 300	2,250
25% benefits		24,068
Total labor	116	$120,338

Logs (25,000 cubic meters @ $60)	$1,500,000
Glue	97,250
Parts and supplies	20,000
Power	12,000
Depreciation	169,400
Fixed costs	25,000
	$1,943,988

6. Details of sliced plywood investment in equipment and building:

Barker	$30,000
Log rollways	2,000
Chainsaw	1,500
Hoist	15,000
Metal detector	9,000
Hot water vat	5,000
CD - 4 saw	5,000
Slicer	75,000
Dryer	100,000
Clipper	14,000
Jointer	20,000
Tapeless splicer	40,000
Glue spreader	10,000
Pre-press	60,000
Press	120,000
Saw line	28,000
Sander	90,000
Blower system	30,000
Specialty saw	16,000
Core saw	2,500
Fuel hog	15,000
Chipper	15,000
3 fork lift trucks	21,000
Rolls and conveyors	10,000
Glue mixer and tanks	12,000
Total equipment	$746,000
Freight	74,000
Installation	80,000
Site preparation	
Press pit and foundations	
Building	
Boiler plant	
Piping	
Power hookup	
Estimated cost	800,000
Total plant and equipment cost	$1,700,000
Working capital	708,000
	$2,408,000

Particleboard Plant

1. Capital investment $1,030,000

2. Particleboard sales (28,000 cubic meters @ $53)	1,484,000
Annual production costs	759,100
Gross annual profit	$ 724,900

3. Profit return on sales = 49 percent
Annual profit return on investment = 70 percent

4. 62 employees
620 man days per 1,000 cubic meters of board processed

5. Details of annual costs:

Unskilled workers	19 @ $1.40/day x 300	$7,980
Semiskilled	26 @ 3.60/day x 300	28,080
Skilled	10 @ 4.20/day x 300	12,600
Foremen	3 @ 4.40/day x 300	3,960
Manager	1 @ Annual salary	12,000
Office staff	3 @ 2.50/day x 300	2,250
25% benefits		16,730
Total labor	62	$83,600

Residue (30,300 cubic meters @ $5)	$151,500
Resin and wax	267,110
Fuel oil (dryer)	60,000
Parts and supplies	40,000
Power	40,000
Depreciation	91,900
Fixed costs	25,000
Total costs	$759,100

6. Details of particleboard investment in equipment and building:

Barker	$30,000
Chipper	30,000
Refiner	30,000
Dryer	40,000
Mixer	8,000
Blender	10,000
Former	90,000
Pre-press	60,000
Hot press	120,000
Trim saws	28,000
Conveyors	40,000
Blower system	45,000
Boiler	100,000
Power hookup	15,000
Wiring	9,000
Piping	3,000

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Building	$96,000
Site preparation	10,000
Fork lift trucks	20,000
Chip silo	4,000
Unloader	2,000
Bins	6,000
Fuel hog	6,000
Freight	77,000
Installation	40,000
Total plant and equipment	$919,000
Working capital	111,000
Total investment	$1,030,000

Small Sawmills

Three different size sawmills are analyzed for cost and profit potential:

Plan A - 9,000 cubic meters of logs per year

Plan B - 15,000 cubic meters of logs per year
Plan C - 18,000 cubic meters of logs per year

In all three plans $40 per cubic meter is the cost of the logs delivered to the mill site. Gross sale price of the lumber is $85 per cubic meter, f.o.b. mill.

Sawmill Plan A

1. Capital investment $279,000

2. Annual lumber sales (6,000 cubic meters @ $85) 510,000
   Annual production costs 429,550
   Gross annual profit 80,450

3. Profit return on sales = 16 percent
   Annual profit return on investment = 29 percent

4. 29 employees
   966 man days per 1,000 cubic meters of logs processed

5. Details of annual costs:

Unskilled workers	14 @	$1.40/day x 300	$5,880
Semiskilled	6 @	2.80/day x 300	5,040
Skilled	5 @	4.20/day x 300	6,300
Foreman	1 @	4.40/day x 300	1,320
Manager	1 @	Annual salary	12,000
Office staff	2 @	2.50/day x 300	1,500
25% benefits			8,010
Total labor	29		$40,050

Logs (9,000 cubic meters @ $40)	$360,000
Parts and supplies	4,000
Power	3,000
Depreciation	15,000
Fixed costs	7,500
	$429,550

6. Details of sawmill investment in equipment and building:

Log rollways	$2,000
Chain saw	1,000
Hoist	10,000
Metal detector	9,000
48" log band mill	12,767
48" auto feed carriage	15,493
44" log band mill	5,872
44" auto feed carriage	13,755
38" table band re-saw	3,000
36" swing cut-off saw	1,000
Auto band saw sharpener	3,765
Auto band saw attachments	396
Band saw stretcher	766
Band saw brazing clamp	186
Conveyors and rolls	9,000
3-ton fork lift truck	14,000
Installation costs	7,500
Electric wiring	2,500
Freight on equipment	9,500
Building	20,000
Office and equipment	10,000
Total equipment	$151,500
Working capital	127,500
Total investment	$279,000

Sawmill Plan B

1. Capital investment	$394,983
2. Annual lumber sales (10,000 cubic meters @ $85)	850,000
Annual production costs	683,425
Gross annual profit	$166,575

3. Profit return on sales = 20 percent
Annual profit return on investment = 42 percent

4. 39 employees
780 man days per 1,000 cubic meters of logs processed

5. Details of annual costs:

Unskilled workers	20	@ $1.40/day x 300	$ 8,400
Semiskilled	9	@ 2.80/day x 300	7,560
Skilled	6	@ 4.20/day x 300	7,560
Foreman	1	@ Annual salary	1,320
Manager	1	@ Annual salary	12,000
Office staff	2	@ 2.50/day x 300	1,500
25% benefits			9,585
Total labor	39		$47,925

Logs (15,000 cubic meters @ $40)	$600,000
Parts and supplies	5,000
Power	3,500
Depreciation	18,000
Fixed costs	9,000
Total costs	$683,425

6. Details of sawmill investment in equipment and building:

Log rollways	$2,500
Chain saw	1,000
Hoist	10,000
Metal detector	9,000
54" log band mill	11,266
54" auto feed carriage	19,953
48" band mill	9,724
48" auto feed carriage	15,493
2 - 42" table band re-saws	6,434
2 - 30" swing cut-off saws	2,000
Auto band saw sharpener	3,765
Auto band saw attachments	396
Band saw stretcher	766
Band saw brazing clamp	186
Conveyors and rolls	12,000
3-ton fork lift truck	18,000
Installation costs	12,000
Electric wiring	3,000
Freight on equipment	11,000
Building	24,000
Office and equipment	10,000
Total equipment and building	$182,483
Working capital	212,500
Total investment	$394,983

Sawmill Plan C

1. Capital investment	474,980
2. Annual lumber sales (12,000 cubic meters @ $85)	1,020,000
Annual production costs	815,175
Gross annual profit	204,825

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4. 45 employees
750 man days per 1,000 cubic meters of logs processed

5. Details of Annual costs:

Unskilled workers	24 @	$1.40/day x 300	$10,080
Semiskilled	9 @	2.80/day x 300	7,560
Skilled	8 @	4.20/day x 300	10,080
Foreman	1 @	4.40/day x 300	1,320
Manager	1 @	Annual salary	12,000
Office staff	2 @	2.50/day x 300	1,500
25% benefits			10,635
Total labor	45		$53,175

Logs (18,000 cubic meters @ $40)	$720,000
Parts and supplies	6,000
Power	4,000
Depreciation	22,000
Fixed costs	10,000
Total costs	$815,175

6. Details of sawmill investment in equipment and building:

Log rollways	$3,000
Chain saw	1,500
Hoist	15,000
Metal detector	9,000
60" log band mill	12,793
60" auto feed carriage	21,987
54" band mill	11,266
54" auto feed carriage	19,953
4 - 42" table band saws	12,868
2 - 36" swing cut-off saws	2,000
Auto band saw sharpener	3,765
Auto band saw attachments	396
Band saw stretcher	766
Band saw brazing clamp	186
Conveyors and rolls	15,000
5-ton fork lift truck	25,000
Installation costs	14,000
Electric wiring	3,500
Freight on equipment	12,000
Building	26,000
Office and equipment	10,000
Total equipment	$219,980
Working capital	255,000
Total investment	$474,980

Chipping Plants--10,000 Tons/Month

1. Capital investment $1,120,000

2.	Annual chip sales (120,000 tons @ $35 f.o.b.	4,200,000
	Annual production costs	3,329,762
	Gross annual profit	$ 870,238
3.	Profit return on sales = 21 percent	
	Profit return on investment = 78 percent	

4. 54 employees
68 man days per 1,000 cubic meters of wood chipped

5. Details of annual costs:

Unskilled workers	30 @	$1.40/day x 300	$12,600
Semiskilled	10 @	3.60/day x 300	10,800
Skilled	5 @	4.20/day x 300	6,300
Foremen	3 @	4.40/day x 300	3,960
Manager	1 @	Annual salary	12,000
Office staff	5 @	2.50/day x 300	3,750
25% benefits			12,352
Total labor	54		$61,762

Wood (240,000 cubic meters @ $12)	$2,880,000
5% dealer costs	144,000
Total wood cost	$3,024,000
Power	40,000
Spare parts	18,000
Depreciation	42,000
Fixed costs	24,000
Ship loading @ 1 per ton	120,000
Total costs	$3,329,762

6. Details of chipping plant investment:

Site preparation	$17,000
Surfacing @ $2.50 square yard	60,000
Shop and office building	15,000
Office equipment	2,000
Shed over chipper	7,500
Transformers	6,000
Chipper	50,000
Motor	4,000
Chip screen	7,500
Rechipper	25,000
Blower	15,000
Feed conveyor	2,000
Piping	3,000
Wiring	3,000
Knife grinder	10,000

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Blower for loading chips	$50,000
Towers and cable	15,000
Barking equipment	100,000
Freight on equipment	14,000
Installation	14,000
Total equipment and building	$420,000
Working capital	700,000
Total investment	$1,120,000

<u>Chipping Plant--20,000 Tons/Month</u>

1. Capital investment — $1,997,000

2. Annual chip sales (240,000 tons @ $35 f.o.b.) — 8,400,000
   Annual production costs — 6,548,260
   $1,851,740

3. Profit return on sales = 22 percent
   Annual profit return on investment = 93 percent

4. 72 employees
   45 man days per 1,000 cubic meters of wood chipped

5. Details of annual cost:

Unskilled workers	44 @	$1.40/day x 300	$18,480
Semiskilled	12 @	3.60/day x 300	12,960
Skilled	7 @	4.20/day x 300	8,820
Foremen	3 @	4.40/day x 300	3,960
Manager	1 @	Annual salary	12,000
Office staff	5 @	2.50/day x 300	3,750
25% benefits			14,990
Total labor	72		$74,960

Wood (480,000 cubic meters @ $12)	$5,760,000
5% dealers costs	288,000
Total wood cost	$6,048,000

Power	60,000
Spare parts	36,000
Depreciation	59,000
Fixed costs	30,300
Ship loading @ $1 per ton	240,000
Total costs	$6,548,260

6. Details of chipping plant investment:

Site preparation	$17,000
Surfacing @ $2.50 square yard	60,000
Shop and office building	15,000
Office equipment	2,000
Shed over chippers	10,000

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Transformers	$10,000
2 - chippers	100,000
2 - motors	12,000
1 - screen	8,000
1 - rechipper	30,000
2 - blowers	30,000
2 - feed conveyors	3,000
Piping	6,000
Wiring	4,000
Knife grinder	10,000
Blower for loading chips	75,000
Towers and cable	20,000
Barking equipment	150,000
Freight on equipment	15,000
Installation	20,000
Total equipment and building	$597,000
Working capital	1,400,000
Investment	$1,997,000